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## EDITORIAL.

**Storage of Grain.** The publication in this number of an article by Dr. H. W. Jack, on the results of experiments concerned with the storage of rice, directs attention to a subject which, in one form or another, has engaged the attention of many countries. Local reasons may dictate the nature of the particular enquiry and the class of grain concerned, but all these problems possess features in common, so that in the examination of one's local problem, the cognate problems in other countries are well worthy of study.

The main object is to protect grain against mould and insect attacks. The immediate problem in Malaya is to ensure an adequate supply of rice within the country. In this connection, it must be remembered that while over 90 per cent of Malaya's population are rice-eaters, local production can only account for about 40 per cent of the requirements of the country. It is desirable, therefore, that within our shores shall be sufficient supplies of rice to secure the immediate future against unforeseen shortage of supplies.

Ceylon was faced with the problem of the storage of rice. It became necessary in that Colony to ensure the proper storage of rice with the object of preventing the outbreak and spread of plague. Municipal granaries were therefore erected in Colombo and certain regulations framed making compulsory the storage of rice in these granaries. An examination of the construction of the granaries and of the organisation of this storage is of particular interest in the consideration of our own problem. Mr. Bunting, Agriculturist, has visited the Municipal Granaries, Colombo. His report on this subject will be published in this Journal in the near future.

The problem of rice storage bears similarities with that of the storage of maize. Maize differs from most other grains in that the testa is less hard than, for example, padi, wheat, barley or oats, and is in consequence, more easily damaged by insects; while if it is stored in a moist condition, it is very liable to be damaged by moulds. In this respect it rather closely resembles cleaned rice, so that much of the data that has accumulated on the question of storing maize in bulk is applicable to the problem of rice storage.

Grain may be protected against moulds by drying to a moisture content not exceeding 12 to 13 per cent. Protection against insect attack can be secured by storage in tanks or silos which have been rendered insect proof.

To deal with the problem both in the West Indies and in Mauritius, Hess grain driers—capable of handling about 200 tons of grain—were erected. These driers were capable of reducing the grain to the suitable condition of dryness. Storage tanks, capable of being hermetically sealed then protected the grain from insect attacks. The employment of these plants shewed that once the grain had been properly conditioned it could be stored for long periods without deterioration.

It is to be noted that preliminary drying of the grain by artificial means is necessary in countries such as Malaya where the climate is hot and damp, it being impossible to reduce the moisture content of the grain to the requisite degree by air drying alone. Insect attack is apparently less likely to occur under dry than under moist climatic conditions.

The above observations are occasioned by the remarks contained in the article in this number, on the possibility of storing rice in silos. If the parallel which has been drawn with maize is exact, there does not seem to be any reason to suppose that it cannot suitably be undertaken on rice; this is directly borne out by laboratory experiments detailed in the article in question. It is curious that bulk storage on the lines envisaged, so far as we are aware, has not been attempted in the rice industry. Further enquiry on these lines, however, appears to promise satisfactory results.

**Tuba Root.** We are indebted to the United States Department of Agriculture for an interesting article which Mr. R. C. Roake of the Insecticide Division of the Bureau of Chemistry and Soils has submitted to us for publication, and which we have pleasure in including in this number. The author headed his article "A large market awaits tuba root (*Derris elliptica*) in the United States" and thus called attention to a subject of considerable importance to planters in Malaya. The Department of Agriculture, S.S. and F.M.S., from time to time has drawn the attention of investigators and insecticidal firms to the properties of this root. Scientists in various countries have concerned themselves with investigations of the toxic principle of the root, and the effect of tuba extract on various insect pests. In this way, our literature on the subject has been much enlarged in the last two or three years. In this Department we have investigated the variations in toxicity in different varieties, and discovered the optimum age for harvesting. That tuba root is receiving increased attention amongst manufacturers of insecticides is becoming apparent, for from time to time we receive enquiries from different countries for supplies. Cultivators of this crop would be well advised, therefore, to place themselves in touch with the Department in order that they may be kept advised of the extending market and may facilitate our endeavours to popularise this product.

**Tea.** We make no apology for returning once more to the subject of tea cultivation, one of the Malaya's infant industries. The increasing number of our readers interested in this crop will welcome Mr. Bunting's article in this journal on the cultivation of tea in Ceylon

The present article read in conjunction with articles which appeared in the January and March 1930 numbers of *The Malayan Agricultural Journal* will enable the reader to envisage the cultural requirements of this crop under Malayan conditions and in the light of the considerable experience gained by Ceylon planters.

**Vernacular Publications.** This Department has for some years endeavoured to make full use of vernacular publications as a means of bringing the large body of Asiatic planters more closely in touch with the work of the Department. While it is realised that demonstration is perhaps the most favourable means of achieving this result—especially in view of the limited scholastic attainments of the majority of the small-holders—yet such a method has its limits; furthermore, there is a growing desire amongst the more advanced Asiatic planters for more precise knowledge of the advance of agricultural practice in this country.

From the experience of the production of vernacular publications, extending over the past eight years, the Department has built up a somewhat unique organisation for the distribution of its vernacular publications.

Up to the present time, such publications have been in the Malay and Chinese languages. The articles have been especially prepared for them and the growing success of this work is evinced by the fact that there is an increasing demand for these publications in all countries where Malay is spoken or where a large population of Chinese agriculturists exists who are engaged on the cultivation of crops of a similar nature to those of Malaya. For instance, the Government of Sarawak has steadily increased its purchase of these quarterly journals in Malay and Chinese, until at the present time it takes 700 copies of all Malay publications and 500 copies of all the Chinese Journals.

The close liaison between the Department of Agriculture and the Rubber Research Institute of Malaya has resulted in a policy whereby the latter body has adopted the Department vernacular publications for the preparation and dissemination of literature in the vernacular. This arrangement has led to a gradual extention of the range of publications. At the present time, for instance, a series of eighteen pamphlets on various aspects of the rubber planting industry are under consideration, which will be published in the Malay, Chinese and Tamil languages. As we write these lines, delivery is being taken of an illustrated leaflet in Chinese and Malay, published at the request of the Government of Pahang, on Methods for the Prevention of Soil Erosion.

While bearing in mind the limitations of this method of applying scientific results to the small-holder, it is evident that the steadily improving standard of education amongst Asiatics renders the method of growing importance and usefulness.

# Original Articles.

## TEA CULTIVATION AND MANUFACTURE IN CEYLON.

BY

B. BUNTING,
*Agriculturist.*

### Introductory.

In view of the interest now being taken in the cultivation of tea in Malaya, the writer took the opportunity during a recent tour in Ceylon, of visiting several tea estates in the mid-country districts of that Colony. Although the visits were far too brief to make a detailed study of either the cultivation or the methods of manufacture of Ceylon tea, which has now become a specialised industry, much information of a general character was collected in the hope that it may prove of value in developing this industry in Malaya.

### Exports of Tea.

The following figures show the comparative exports of tea from Ceylon during the past three years:—

| *Year.* | *Black Tea.* | *Green Tea.* | *Total Value.* |
|---|---|---|---|
| | lbs. | lbs. | Rs. |
| 1927 ... | 225,045,992 | 1,991,864 | 213,774,632 |
| 1928 ... | 234,890,761 | 1,828,628 | 201,311,006 |
| 1929 ... | 250,430,570 | 1,157,442 | 205,194,082 |

### General Conditions.

*Situation of Estates.*—The estates visited were situated at elevations varying from 2,500 to 4,500 feet above sea-level, which is known as mid-country.

*Rainfall.*—The rainfall, which in this particular region is fairly evenly distributed throughout the year, varies from 95 to 110 inches per annum, with approximately 190 rainfall days a year.

*Nature of Land.*—The lie of the land on all the estates visited was distinctly hilly and its steepness may be judged by the fact that on one estate of nearly 2,000 acres there was a range of no less than 2,500 feet in the elevation of the planted area. The necessity for taking steps to prevent soil erosion on such precipitous land is one of the most important problems which has to be faced by the management and will be described in detail later.

The soil for the most part may be described as a loose friable loam overlying quartzite rock. Judging by its colour, it is well supplied with organic matter.

Transport facilities are provided by Government roads adjoining all the estates which were visited so that expenditure both in obtaining supplies and despatching the crop is reduced to a minimum.

*Area of Estates.*—The area of the estates visited varied from 700 acres to about 2,100 acres each, but the latter estate was divided into three divisions with a central factory treating the whole of the crop. An area of 750 to 1,000 acres appears to be an economical unit for mid-country tea, although much smaller units are quite common and can be worked at a profit when the overhead charges are restricted to a reasonable limit.

## Draining and Terracing.

In opening up new land for tea, obviously great care must be given to the question of soil conservation. On steep land an efficient system of drainage, combined with terracing, should be adopted at the outset in order to prevent the loss of valuable surface soil.

When laying out the drains the steepness of the land will decide the distance apart at which they are to be spaced. On very steep land they may be spaced 20 feet apart, but with a medium slope the spacing may be increased up to 30 feet. These drains, which are known as side drains, should be about 18 inches wide and 18 inches deep and not more than 100 to 150 feet in length, with a gradient of about 1 in 30. The main or vertical drains for carrying off the surplus water from the side drains should, as far as possible, follow the natural folds in the land, not be too long, and should be arranged in staggered formation down the slope of the hill. Where rock is available these main drains should be protected with broken stone.

The following system of soil conservation, which is a combination of contour draining, silt-pitting and terracing, was adopted on one of the estates visited and was so effective as to warrant a detailed description:—

On the young clearings, where the land was fairly steep, contour drains were dug at distances of 25 feet apart in the centre of the ridge, i.e. that part of the hillside giving the mean angle of slope. The drains had a gradient of 1 in 50 and were 18 inches wide and 18 inches deep. At intervals of 10 feet in the drain were placed bunds of stone, about 3 inches below the edge of the lower side of the drain, with a catch or silt-pit, 2½ feet long by 1 foot deep, placed on the lower side of the bund to check the flow of water. In addition to this a further bund of stone, 12 inches high, was placed along the upper side of the drains and about 18 inches from the edge. This bund was increased to a height of 18 inches as the soil filled up to the level of the original bund. These drains were not more than 100 feet in length and as far possible, followed the natural depression in the land so that they discharged into the main or leading drains in a natural ravine.

It is suggested that this system could be greatly improved by placing an additional stone terrace, about 9 to 12 inches high, intermediate between the drains in order to save the lower bund from becoming too high as a result of the collection of silt from the slope above.

Climbers and ferns are allowed to grow on the stones forming the terrace so as to bind them together, and as a further precaution against loss of soil, a ground cover of *Indigofera endecaphylla* is now being planted between the terraces.

The management of this estate has fully realised the value of taking every possible precaution for arresting soil erosion on such steep land and there is no doubt that the money expended on this work will be amply repaid in the future by increased yields of tea.

**Planting.**

The distance of planting having been decided upon, the land is then carefully lined and holed ready for planting at the beginning of one or other of the monsoon seasons. It is usual to dig cylindrical holes and these should not be less than 18 inches deep and 12 inches across the top. The earth removed from the holes should be placed between the lines and after allowing the holes to remain open for some days, for the purpose of aeration, they should be filled in with good surface soil ready for planting.

The most suitable spacing of the plants will depend to a certain extent on the situation of the estate and tea grown at higher elevations is usually planted much closer than that at the lower altitudes.

The usual distance of planting in the mid-country districts is 4 ft. × 3 ft., but in some cases 3 ft. 6 ins. by 3 ft. is adopted, especially on wind-swept ridges. On up-country estates 3 ft. 6 ins. × 3 ft. and 3 ft. × 3 ft. appear to be mostly in favour.

The following table shows the number of bushes per acre at various distances of planting:—

| | | | | |
|---|---|---|---|---|
| Bushes planted | 3′ 0″ × 3′ 0″ | = | 5,590 | per acre. |
| ,, ,, | 3′ 6″ × 3′ 6″ | = | 4,170 | ,, ,, |
| ,, ,, | 4′ 0″ × 3′ 0″ | = | 3,630 | ,, ,, |
| ,, ,, | 4′ 0″ × 3′ 6″ | = | 3,111 | ,, ,, |
| ,, ,, | 4′ 0″ × 4′ 0″ | = | 2,722 | ,, ,, |

The various methods of planting up new areas include (a) seed at stake, (b) germinated seed, (c) basket seedlings and (d) plants raised in nursery beds.

One of the best methods is to plant seed at stake, allowing two or three seeds per hole and thin out the weakly plants later. Freshly germinated seed may also be employed for this purpose with satisfactory results, but seed at stake has a better chance of surviving a drought experienced soon after planting than has germinated seed, which has not had time to get its roots established. The seed can be shaded by fern with good results.

When plants are required, the seed is sown in raised nursery beds at a depth of one to two inches and spaced 4 to 6 inches apart. The beds should be lightly shaded and regularly watered until the young seedlings are well established. After about 6 months the shade is removed so as to harden the plants. They should be ready for planting out after about one year, but they may remain in the beds up to a period of two years if necessary. When the plants are removed from the nursery beds, the tap-roots are cut off, leaving about one foot in length, as well as the tops of the plants to within 6 or 8 inches of the collar. A round, pointed, hardwood stick is used for making the hole for planting. Care should be taken that the roots are not bent during the operation of planting and the earth is well pressed round the plant to within about an inch above the collar. The young plants should be shaded with bracken until they become established.

Basket plants or two-year-old stumps are found the most satisfactory for supplying any vacancies which may occur later.

## Weeding.

The system of clean weeding is almost universal on tea estates in Ceylon, but it is somewhat questionable whether the advantages of such a system are not outweighed by its numerous disadvantages, the chief of which is the loss of valuable surface soil as a result of wash.

On the majority of estates a system of monthly hand weeding is adopted, but on others noxious weeds only are removed and indigenous leguminous plants or harmless weeds, such as *Oxalis violacea*, are allowed to grow so as to protect the surface soil on steep slopes liable to wash during heavy rain. Climbers and ferns are also allowed to grow over the stone bunds built to prevent soil erosion so as to bind them together.

## Cover Crops and Green Manures.

The use of low-growing leguminous cover crops has been given a trial on some of the more progressive estates and *Indigofera endecaphylla* is being employed for this purpose. This plant has proved to be a most satisfactory ground cover for estates where it can be established. On some estates, however, *Oxalis violacea*, a non-leguminous plant, is commonly allowed to establish itself and constitutes a fine soil protector.

*Tephrosia candida* (Boga medeloa) and *Leucaena glauca* are employed as green manures to a small extent, but these are not so much used as the more woody type of plants such as *Gliricidia maculata* and *Erythrina lithosperma* (Thornless Dadap).

In one case *Tephrosia candida* was planted on the terraces. The plants are cut back twice a year and the prunings stacked behind the terraces. In another case it was planted about 18 inches above the drains as close together as possible so as to form a hedge. The plants are cut back every three or four months and the cuttings either placed behind the hedge or dug into the soil.

On another estate, with very light soil, it was planted on the terraces and between every other row. In this case it was cut and buried three times a year and uprooted at the end of the third year.

*Gliricidia maculata* and *Erythrina lithosperma* are usually planted 15 feet apart, parallel with the drains, with two plants between the drains, so as to miss the edges of the drains, and in the rows of tea bushes. The plants are cut back to 8 feet at the first pruning so as to get a bowl-shaped tree. Afterwards they are pruned back to within about a foot of the old cut three times a year until the plants get too high, when they are cut back to the original level at 8 feet above the ground. The prunings are dug into the soil by what is called "envelope" forking. In this way large quantities of organic matter are incorporated in the soil. An additional advantage derived from planting leguminous shrubs and trees, such as those described above, is that they have the property of collecting nitrogen from the air by means of nodules on their roots, thus enriching the soil in this important constituent of plant food.

At elevations of 4,000 feet and over *Acacia decurrens* is commonly used for green manuring purposes. The distance of planting will depend on whether the plants are required to serve as a wind-break in addition to providing supplies of green manure. In the former case the trees are usually planted in belts 18 to 20 feet apart and 10 to 12 feet between each tree in the rows, depending on the spacing of the tea.

### Shade Trees and Windbreaks.

*Albizzia moluccana* is universally employed as high light shade. The trees are usually planted 40 ft. × 40 ft. in new clearings. Later, every other tree in alternate rows is cut out and eventually the remaining trees in these rows are removed, leaving a spacing of 80 ft. × 40 ft. or approximately 15 trees per acre. The rows of shade trees should run north and south in order that the tea bushes may receive the maximum amount of shade. This tree does not stand pruning as it contracts disease and always dies back afterwards.

*Grevillea robusta,* although providing a certain amount of shade, is planted as a wind-bread on the more exposed ridges. For this purpose it is planted in double rows about 6 feet apart, the plants being alternated to form a screen. The rows are planted either against the prevailing winds or on the edges of paths and may be spaced several chains apart. The leaf-fall from these trees makes a splendid ground mulch.

### Pruning.

There are numerous systems of pruning tea and it is impossible to lay down any hard and fast rules as to the method of pruning. In each case the main object is to promote vigorous growth with a view to maintaining the production of leaf. The operation should, as far as possible, be carried out at the beginning of a wet season because at this stage the bushes are full of sap, which naturally promotes a flush of new and vigorous growth.

The following is a brief description of the system of pruning which was adopted on an estate in mid-country:—

Whether the tea is planted from seed at stake or germinated seedlings, after about 9 months growth, or when the seedlings are roughly 9 inches in height, they are pruned back to within 3 inches of the ground or the lowest leaf or side shoot. They are allowed to grow up again and 9 months later are cut back to within 6 inches of the ground, i.e., 3 inches above the old cut, just above an outward bud. A further 8 or 9 months later they are again cut back to within 3 inches of the previous cut leaving 9 inches of wood. After this stage ordinary plucking takes place, leaving one leaf above the fish leaf, care being taken not to pluck shoots below the level and leaving outward growing branches to develop frames. At each cutting outward growth is encouraged and centre upward growth checked.

Subsequently, normal one and a half or two years pruning is adopted according to the development of the bushes. Such pruning is only carried out from the beginning of April to the middle of September. The reason for this is that the April rains, which follow the drought during the periods January to March, cause a strong flow of sap which encourages callus growth on the edges of the cuts and vigorous new shoots. The bushes are pruned roughly to a level, but pruning to an outward bud is equally important so as to encourage outward growth. The good growing months are September, October and November, but the best flushes are usually obtained in April and May although such flushes are of comparatively short duration.

A new clearing planted from seed at stake in July/August, 1927 under the above system of pruning was put into plucking during March, 1930. The method adopted resulted in the production of a large number of side branches making the frame and in less than three years from the time of planting the bushes average 24 inches across the top.

Once the bushes come into plucking the interval between prunings may vary from two years on mid-country estates up to three or even four years on up-country estates.

## Plucking.

The first plucking, which is really tipping to get the bush into formation, sometimes takes place 6 weeks after pruning, but generally after 2 months on mid-country estates. At the higher elevations it may take up to 3 months before plucking is recommenced, but the period depends on the style of pruning adopted.

The present system of plucking is to take a bud and two leaves only, leaving one leaf above the fish leaf. At the same time the "bangy" or abortive shoot is collected to encourage flushing. The old system was to take the bud or tip and two leaves and if a third leaf was present above the fish leaf take three-quarters of it and throw away the lower portion of the stalk. The latter gives the red leaf and hard stalk which has to be removed by hand-sorting. Normally, there should not be a third leaf present above the fish leaf if the plucking round is carried out quick enough. Plucking usually takes place at intervals

of 9 or 10 days, but in the rush seasons, i.e., April/May and September/October, the interval between plucking is reduced to 7 or 8 days.

Following pruning, the more experienced coolies pluck the bushes for 9 months or a year when they will gather from 40 to 60 lbs. of fresh leaf per day. After this the old women and children take it over and carry on until the bushes are due for pruning again. During the latter period the average amount of fresh leaf plucked daily will vary from 13 to 18 lbs. per cooly.

On another estate, where plucking is carried out regularly at intervals of 8 or 9 days, a cooly will pluck as much as 40 to 60 lbs. of fresh leaf per day during the heavy flush and about 10 lbs. of leaf per day when the flush is poor. Taken over the whole year an average of about 18 lbs. of fresh leaf per cooly per day may be considered satisfactory. A plucker receives a bonus of one cent per pound for anything above 20 lbs. per day.

Plucking goes on all the year round and a permanent gang of about 250 women pluckers is required for every 500 acres of tea in bearing.

The egg-shaped plucking basket is considered preferable to other types since the leaf is much less liable to become bruised during plucking operations. The size of the plucking baskets is 30 inches deep and from 14 to 16 inches in diameter. On no account should the leaf be pressed down in the baskets and for this reason frequent collection and despatch of the green leaf from the field to the factory is essential, more particularly during the heavy flushes.

## Cultivation and Manuring.

The cultivation of tea is generally restricted to forking, either in connection with the application of artificial fertilisers or in the periodical incorporation of prunings of green manures by what is known as "envelope" forking. Hand-digging with forks not only aerates the soil but has the effect of conserving soil moisture by reducing the surface evaporation, which naturally takes place on hard baked soils.

The continuous cropping of the tea plant rapidly denudes the soil of its essential constituents of plant food and it is therefore necessary that both forking and periodical digging in of green manures be supplemented by the regular application of artificial manures, in some form or other, in order to maintain the health and vigour of the plant.

The present practice in Ceylon is to apply what is known as a "pruning mixture" a few months before pruning takes place and this is followed by a " general mixture," which is usually applied about nine months or a year after pruning.

The composition of the mixtures varies considerably on different estates, but the system adopted on one estate was to apply 1,000 lbs. of fertilisers over a period of two years to cover a two-year pruning cycle. The two mixtures are made up as follows:—

(a) *Pruning Mixture.*

| | | *Nitrogen.* | *Phosphoric Acid.* | *Potash.* |
|---|---|---|---|---|
| 150 lbs. | Fish guano | 10.5 | 12 | — |
| 80 ,, | Nitrate of potash | 8 | — | 26.4 |
| 100 ,, | Ephos phosphate | — | 30 | — |
| 70 ,, | Sulphate of ammonia | 14 | — | — |
| 50 ,, | Superphosphate | — | 9 | — |
| 450 lbs. | | | | |

(b) *General Mixture.*

| | | | | |
|---|---|---|---|---|
| 100 lbs. | Groundnut cake | 7 | — | — |
| 200 ,, | Fish guano | 14 | 16 | — |
| 50 ,, | Muriate of potash | — | — | 25 |
| 100 ,, | Blood meal | 11 | — | — |
| 50 ,, | Sulphate of ammonia | 10 | — | — |
| 50 ,, | Superphosphate | — | 9 | — |
| 550 lbs. | | | | |

On some older areas the general mixture has been increased to 750 lbs. per acre on account of the largely increased size of the bushes.

The common method of applying these mixtures is to broadcast the manure in the lines between the bushes. The forking gang then follows and fork it in below the surface. Another method is to sprinkle the mixture in a circle about 18 inches round the bushes and fork it into the soil.

The loppings from the green manures, such as *Gliricidia maculata* and *Erythrina lithosperma*, are incorporated with the soil by "envelope" forking at the same time as the artificials are applied. The artificial manures add 10 cents per lb. to the cost of the prepared tea and on some of the more progressive estates an equal amount is expended on green manuring with excellent results as regards increase in yield, new wood growth, callus healing of wounds and well developed frames.

(c) *New Clearing Mixture*

| | | *Nitrogen.* | *Phosphoric Acid.* | *Potash.* |
|---|---|---|---|---|
| 50 lbs. | Fish guano | 3·5 | 4 | — |
| 50 ,, | Sulphate of ammonia | 10 | — | — |
| 150 ,, | Superphosphate | — | 27 | — |
| 250 lbs. | | | | |

The above mixture is applied to plants after centering at the rate of 2 ozs. per bush. It is dibbled in at a distance of about 6 inches around the young bushes.

### Diseases and Pests.

Brown root disease (*Fomes lamaoensis*), Poria (*Poria hypolateritia*), Ustulina and Diplodia (*Botryo diplodia*) are amongst the most prevalent diseases of tea in Ceylon.

The burying of tea prunings among the bushes frequently contributes to the outbreak of these diseases.

One of the principal pests is the shot-hole borer, (*Xyleborus fornicatus*) which is always existent and is most noticeable by broken branches about 18 months after pruning. The beetle perforates the stems and branches making a circular gallery where it lays its eggs. The entrance is usually at a node. When bushes are weak the branches snap off at the gallery, thus ruining the frames. There is no cure for this trying pest, but manuring—by maintaining the vigour of the bushes—helps the bushes to fight against the attack.

The best method of combating pests and diseases is by adopting preventive measures and not allowing the bushes to become weakened either by hard plucking or by permitting them to grow too high before pruning.

The caterpillar of the tea tortrix (*Homona coffearia.*) is also responsible for much damage. The methods adopted for the control of this pest are not altogether satisfactory, but it has been established that tea bushes which are regularly manured and kept in a good state of cultivation are much less susceptible to the attacks of the pest. Various species of termites also cause considerable damage and require to be kept in check.

### Seed-Bearers.

Since the importation of tea seed from India and Assam is at present prohibited, it is necessary for Ceylon to rely entirely on locally produced seed for planting up new areas or supplying old ones. On some estates, therefore, small areas of tea plants are not pruned or plucked, but allowed to develop as seed-bearers.

The tea plant is very liable to cross fertilisation, consequently it is better to select seed of a first class jat and plant up a small area in the jungle where it can be completely isolated from all other jats. In this case it should be planted at distances of 12 ft. × 12 ft. or even 15 ft. × 15 ft. and allowed to grow naturally into the form of a tree. After about 4 or 5 years from planting the trees will begin to produce good crops of seed, but they do not reach maturity until they are from 8 to 10 years old. It takes about 14 to 15 months from the time of flowering to the production of ripe seeds and it is stated that a yield of from 10 to 15 maunds of good seed is obtained per acre according to conditions.

### Manufacture.

Although the general principles of the method of manufacture of tea are much the same throughout the Island, there is considerable variation in carry-

ing out the different processes even on adjoining estates and it is, therefore, only possible to give a rough outline of the procedure generally adopted in the factory.

The various processes through which the leaf passes in the factory include (a) withering, (b) rolling and roll-breaking, (c) fermenting, (d) firing or drying, and (e) grading. These operations are briefly described below:—

## Withering.

This is probably the most important operation in the manufacture of black tea and many factors have to be considered in order to obtain a good and even wither.

The fresh leaf on arrival at the factory is first weighed and then transferred to the withering loft, where it is spread out in thin layers on tats made of hessian. The height of the withering loft is 8 ft. 6 ins. and each frame carries 17 tats, which are spaced 5 inches apart, leaving extra space near the ceiling to allow of free circulation of air. The tats are usually 40 feet long and consist of a double bank of 45 in. hessian, which is sewn together at the centre and then secured to a permanent wire frame by means of small wooden pegs. If a wire frame is not used, considerable space is lost by the edges of the tats curling. The tats have a slope 3 inches downwards from the centre to facilitate the removal of the withered leaf. The passage between the tats is from 22 to 24 inches wide and that on the ends about 3 feet wide.

The loft is fitted with a large number of glass windows of the single venetian type, which can be opened in dry weather to allow of the free circulation of air. A bulking chamber is fitted in the centre of each loft and two large "boosting" fans placed in this chamber draw hot air from the drying room, which is bulked with air from the atmosphere. The mixture of hot and cool air is then pushed through the lofts to regulate the humidity. In other cases two exhaust fans are placed at the end of each loft for controlling the movement of the air inside the lofts.

The fresh leaf is spread very thinly on the tats, the usual practice being to allow 1 lb. of fresh leaf to 15 square feet of tat space. Assuming that each tat contains 127½ square feet it would therefore take 8½ lbs. of fresh leaf. In order to get an even distribution on the tats it is advisable to provide the cooly with a basket holding sufficient leaf for one tat.

The withering process, in favourable weather, usually takes 18 hours to complete. It may, however, proceed up to 24 hours with good results, but after this the leaf begins to decompose and smell. When the leaf is properly withered it has an apple-like smell and if pressed in the hand will expand slowly like a silk handkerchief does when treated in the same way. A wither of 53 to 56 per cent. is considered the best for general purposes, but in some cases it may be from 55 to 58 per cent. The leaf on arrival at the factory contains about 75 per cent. of moisture so that a wither of 55 per cent. means that 100 lbs. of fresh leaf has lost 45 lbs. of water during the process of withering.

Hygrometers should be placed both on the outside and on the inside of the loft and the temperature of the dry and wet bulbs recorded daily at 7 a.m., 1 p.m., and 4 p.m. for the purpose of regulating the humidity of the loft.

The following hygrometer readings were observed in one loft at 10.30 a.m. :—

| | *Inside Loft.* | *Outside Loft.* |
|---|---|---|
| Dry bulb | ... 82°F. | 78°F. |
| Wet bulb | ... 76°F. | 70°F. |

The difference of 6°F. in the wet and dry bulb inside the loft is considered ideal conditions for withering.

In dry weather the free circulation of air is regulated by opening the windows on the sides of the loft, but during moist weather the hot air from the drying room is passed into a central bulking chamber, fitted with wooden shutters, and drawn through the loft by means of large suction fans placed at each end.

The leaf is not turned during the withering process, but boys are sent round to break up any lumps and see that the spreading of the leaf on the tats is uniform. The leaf should be handled as little as possible in the factory as well as in the field. Further, only sufficient leaf should be removed from the tats to fill the rollers, because if it is allowed to remain in heaps on the floor of the loft it will begin to ferment and deteriorate in quality. The first leaf should be weighed when it arrives at the factory and a record kept of the quantity of leaf placed on each bank of tats. The actual degree of withering may be ascertained by weighing a definite quantity of leaf and comparing it with the weight on arrival at the factory. It will then be possible to check the number of tats which must be cleared to provide the necessary charge for the rollers.

## Rolling.

When the leaf is withered the next process is that of rolling. In this operation the withered leaf is placed in the roller, which usually consists of a fixed table, covered with battens, a bottomless box and an adjustable lid. As a rule the table is stationary, but the box and its lid revolve eccentrically on the table at a speed of about 40 revolutions per minute. This movement causes a certain amount of friction with the result that the leaf becomes heated, which in turn produces fermentation. It is therefore necessary to regulate the pressure on the leaf by means of the adjustable lid and in practice little or no pressure is applied during the first period of rolling. In subsequent rollings, however, the lid is lowered into the box and pressure is thereby exerted on the leaf and the pressure is gradually increased until the final rolling. There is so much heat generated during hard rolling that it is necessary to lift the lid periodically for a few minutes so as to allow the leaf to cool down.

There are many systems of rolling which vary from 3 rolls of long duration to 5 or more rolls of short duration, the extent of rolling being much the same in each case. In actual practice, the time taken in rolling and the

fermentation of the tea generally occupies about $3\frac{1}{2}$ hours for the two processes, which are really combined, as will be described later.

The general practice in Ceylon is to roll for a period of 2 to $2\frac{1}{2}$ hours with rolls of varying duration, which can only be determined by experience in manufacture.

The rolled leaf is passed over the roll-breaker after each roll and that portion passing through the No. 5 mesh is termed "dhool" and comprises what is known as the broken grades, while the portion passing over the top of the wire mesh is known as "bulk". When the rolled leaf after the first roll is passed over the roll-breaker, the fine leaf and tips are separated from the coarse leaf so that light pressure can then be applied to the remaining bulk, the pressure being gradually increased after each period of rolling.

The following are examples of the different systems of rolling adopted on four estates situated in mid-country within a comparatively short distance of each other :—

*Estate A.*—The former method of rolling consisted of 8 periods; the first 3 rolls for 30 minutes each and the next five rolls for 20 minutes each, the leaf being passed through the roll-breaker after each period of rolling. No pressure is applied during the first roll, very little during the second and third, but the pressure is gradually increased until finally hard pressure is reached. If a 52 per cent. wither is obtained the pressure can be applied harder after the second roll.

The present system consists of 7 rolls comprising two rolls of 30 minutes, three rolls of 20 minutes and two rolls of 15 minutes. If the leaf is not too much withered another roll of 15 minutes is given.

*Estate B.*—The method of rolling at present adopted is 5 rolls of 30 minutes each. There is no pressure on the first roll, light pressure on the second and heavy pressure on the last three rolls. In the latter case the pressure is maintained for periods of 10 minutes and then the lid is lifted for 2 or 3 minutes to allow the leaf to cool down. Three rolls are filled with leaf at the same time and after the first roll the big bulk is combined in two machines and after the fourth roll into one machine.

*Estate C.*—The method of rolling adopted on this estate was 5 rolls, comprising 3 rolls of 30 minutes each and two rolls of 20 minutes each, all hard pressure in order to get as much broken leaf as possible with a view to obtaining strength and colour.

*Estate D.*—The present method of rolling consists of 5 rolls of 30 minutes each as follows :—

1st Roll—30 minutes, no pressure with lid just touching the leaf.
2nd Roll—30 minutes, lid 5 minutes on and 10 minutes off.
3rd Roll—30 minutes, lid 10 minutes on and 5 minutes off.
4th and 5th Rolls—30 minutes each, as hard as possible without heating the leaf.

This gives 2½ hours actual rolling, but allowing a quarter of an hour for each breaking process, one hour altogether, the whole operation of rolling takes 3½ hours to complete.

It will be seen from the above examples that there is considerable variation both in the number of times rolled and their duration. This variation depends on the grade of tea to be manufactured; where a large percentage of broken grades is required the pressure is increased so that more leaf passes through the roll-breaker. The hard rolling gives the tea strength, whereas light rolling, in which the leaf is kept as cool as possible, gives it flavour.

The tables on which the rollers work are sometimes made of brass, but more usually of wood. It is stated that wooden tables give a better grip on the leaf when rolling and that tea rolled on wood frequently realises a higher price than that rolled on brass. The drawback is that wooden tables require renewing every 18 months, whereas brass is far more lasting. The tables are fitted with battens, which give the leaf a twist or curled appearance. There are many types of battens, but Reeves battens are probably the most popular.

It is estimated that one full-sized 36 inch roller is required for every 65,000 lbs. of made tea so that the factory will be fully equipped. Many factories, however, are equipped with one roller for every 80,000 lbs. or up to 100,000 lbs. of made tea, which is generally inadequate. In practice, a 36 inch roller will take a charge of about 300 lbs. of withered leaf, although the makers usually estimate its capacity at 360 lbs. per charge.

The speed at which the rollers revolve may vary from 20 to even 60 revolutions per minute as extreme limits, which will depend on the type of roller and the form of battens fitted to the table. For general purposes a roller with a fixed table should work at about 35 to 40 revolutions per minute.

It is of great importance that the rolling room should be as cool as possible and provided with a free circulation of fresh air so as to retard the process of fermentation.

## Fermentation.

The process of fermentation is generally carried out on tables situated in the rolling room, but in some cases a separate fermenting room is provided for this purpose.

The fermenting tables are usually made of angle iron, expanded metal and concrete. Ordinary wire may, however, be used instead of expanded metal. The layer of concrete should not be more than 1½ inches thick and each rack should have either 2 or 3 shelves. It is found that concrete is better than glass for fermenting as the latter is too clean and consequently retards the bacterial action so necessary to fermentation.

The dhool coming from the roll-breaker is placed on the fermenting trays to a uniform depth of 1½ to 2 inches. In one case the first two lots of dhool are allowed to ferment on the tables for 1 hour, the remainder going straight from the roll-breaker to the firing machine, having fermented sufficiently during the rolling process. In another case the first lot of dhool is left on the fer-

menting trays for a period of 1 to 1½ hours, the balance remaining on the trays for shorter periods, according to the length of rolling, and only the last lot of dhool going straight to the firing machine. In both cases the fermenting tables are placed at one end of the rolling room.

On another estate, which had a separate room for fermenting, the first three lots of dhool are fermented on the trays for a period of 2½ to 3 hours, the last two dhools being taken direct to the drier for firing.

Since the process of fermentation goes on during the operation of rolling it is nearing completion as the last roll is finished and the coarse leaf is therefore fermented while in the roller.

The temperature of the fermenting room should not be allowed to exceed 70° to 75°F. On one estate visited, the rolling and fermenting rooms were combined and the temperatures in three different places in this room were as follows:—

(1) Dry bulb = 68.5°F. and wet bulb 69.0°F. (near humidifier)
(2) ,, = 69.5°F. ,, ,, 69.5°F. (centre of room)
(3) ,, = 70.25°F. ,, ,, 70.5°F. (end of room)

These are considered ideal temperatures for rolling and fermenting. The corresponding outside temperatures were—dry bulb 75.5°F. and wet bulb 68.25°F.

When a separate room is used for fermenting, it is usually constructed of brick walls with pigeon holes on one side. One end of the room is partially open and this opening is covered with wet sacking, while an exhaust fan, placed at ground level at the other end, draws the moist air through the room, thereby increasing in humidity.

The humidity of the atmosphere of the fermenting room should be kept as near saturation point as possible so as to prevent any drying of the fermenting leaf.

In order to achieve the best results cleanliness in both the fermenting and the rolling rooms must be strictly observed.

## Firing.

The principal object of firing the leaf is to extract the surplus moisture and thereby to arrest fermentation.

The fermented leaf is transferred from the fermenting room in a specially made box or basket holding exactly 5 or 8 lbs. of leaf according to the capacity of the trays. The leaf is then spread evenly on the tray to a depth of about half an inch. The length of time taken in firing the leaf will depend on (a) the temperature of the drier, (b) the thickness at which the leaf is spread on the trays and (c) the extent of the wither.

The following figures show the various temperatures and the duration of firing on four different estates:—

| | *Temperature of drier.* | *Duration of firing.* |
|---|---|---|
| Estate "A" | 175° to 180°F. | 15 to 20 minutes. |
| ,, "B" | 180°F. | 20 ,, |
| ,, "C" | 180° to 190°F. | 20 to 25 ,, |
| ,, "D" | 200° to 220°F. | 25 to 30 ,, |

When the tea leaves the drier it should be quite crisp and if properly dry, the coarser leaves can easily be crushed into a powder when rubbed between the hands. Immediately after its removal from the drier, the fired leaf is spread out on the floor of the drying room and allowed to cool, after which it is placed in either zinc or wooden airtight bins, where it is stored ready for sifting and grading. It should be placed in the storage bins while slightly warm.

Attention should be drawn to the fact that the capacity of a drier is generally about half that estimated by the makers. The reason for this is that the makers base the capacity on a temperature of 220° to 230°F. and a wither of 60 per cent., whereas the common practice in Ceylon is to fire the tea at a temperature of 180° to 200°F. with a 50 to 55 per cent. wither.

### Final Firing.

It is usual to give the sorted tea a final firing at a slightly lower temperature immediately before packing so as to remove any surplus moisture.

### Sifting.

The fired tea is next transferred from the storage bins to the sifting room, where it is passed through sifting machines which separate the tea into 7 or 8 different grades according to size.

A separate room should always be provided for sifting the tea. A 36 inch exhaust fan is placed at floor level at one end of the sifting room to draw away the fluff.

In the process of sifting, the dhool is passed through a standard 4 tray sifting machine producing five grades of tea. The first grade is Broken Orange Pekoe and Orange Pekoe from No. 10 sieve, the second Pekoe from No. 8 sieve and the third heavy bulk from No. 6 sieve. The latter is put into a cutting machine and sized. After sizing it is put back into the sifting machine where it is graded into Broken Pekoe, Pekoe and Pekoe Souchong.

The Broken Orange Pekoe and Orange Pekoe are whole leaf uncut teas, while Fannings and Dust come from Nos. 24 and 30 sieves.

All the big bulk is hand-picked for the removal of red leaf and hard stalks. This is carried out by women who work on zinc-covered tables.

The following is a list of the various grades of tea which are manufactured on one mid-country estate, together with the percentage of each grade produced under present conditions:—

| | | |
|---|---|---|
| Broken Orange Pekoe | ... | 51.65 per cent. |
| Broken Pekoe | ... | 11.55 ,, |
| Orange Pekoe | ... | 6.30 ,, |

| | | | |
|---|---|---|---|
| Pekoe Souchong | ... | 2.05 | ,, |
| Souchong | ... | 1.24 | ,, |
| Pekoe | ... | 23.93 | ,, |
| Fannings | ... | 2.40 | ,, |
| Dust | ... | 0.88 | ,, |
| | | 100.00 | per cent. |

The tea cutter is usually fitted with either 5/6″ or 1/4″ cells and on some estates they have two cutting machines, one of each size. In this case the tea is passed through the 5/16″ cell cutter and then transferred to the 1/4″ cell cutter for final cutting. Where only one size cutting machine is employed it is necessary to pass the big bulk tea through the cutter several times.

The percentage of made tea to fresh leaf, without deducting anything for surplus moisture of the leaf during wet weather, is approximately 23.5 per cent. taken over the whole year. This figure was obtained in a mid-country district with a rainfall of about 95 inches per annum. After sifting, the different grades are stored in bins until there is a sufficient break of each ready for packing. As a rule the tea is stored in the bins for about a week, but some of the lower grades are kept up to 3 months. These storage bins are usually constructed of teak and are 4 feet wide i.e., 2 feet on either side of the partition between the sifting and packing rooms. Sometimes the bins have sufficient clearance as the base to allow of a packing case being placed below.

## Packing.

Before packing, each grade of tea is carefully bulked on the floor of the drying room so that the various days' makes of the same grade will be thoroughly mixed together. The bulked tea is then placed in the drier for about 2 or 3 minutes and refired at a temperature of 80° to 90°F. after which it is packed in lead-lined momi or venesta cases while it is still warm, but not hot.

During the operation of packing, the chest is clamped on a vibrating table which gives a shaking motion backwards and forwards, thus ensuring that the maximum quantity of tea is packed in each chest. A full-sized chest contains approximately 115 lbs. of B.O.P., while Fannings and Dust, being heavier, are usually packed in half chests containing 85 to 100 lbs. nett weight.

A break is 1,000 lbs. or over and is sold in the open market, lesser quantities being disposed of at the auctions after the large breaks have been sold.

## Factory.

The tea factory should be a cool, airy, well-lighted building and situated in an open position about the centre of the estate.

The ground floor contains all the machinery and is usually divided up into (a) rolling and fermenting room, (b) firing and packing rooms, and (c) sifting

and grading room. There are generally two or three upper floors which are fitted with double banks of tats for withering the leaf.

The long axis of the factory building should run east to west and the rolling room should preferably be located on the west end of the building, so as to be as cool as possible, the firing and packing room in the centre and the sifting and grading room, which should be well lighted, at the opposite end.

The height of the withering loft is generally 8 feet from the floor to the ceiling, but in some cases the height of the first loft is 8 ft. 6 ins. and the other two lofts 8 feet only. These lofts should be well provided with windows, which can be easily opened so as to allow of the free circulation of air inside.

Formerly, when the leaf was spread very much thicker than it is at present, two withering lofts were considered sufficient, but with an allowance of 1 lb. of fresh leaf per 15 square feet of tat space, a third loft is now required.

Outside lean-to verandahs are generally erected along the sides of the ground floor so as to give more floor space. The roofs of these verandahs are taken up to the lower edge of the windows in the first floor withering loft so as to give increased height and allow of better lighting.

Great care and attention is given to the cleanliness of the tea factories and the cleaning of each room is systematically carried out so as to prevent any dust or rubbish becoming mixed with the tea while it is passing through the various processes of manufacture.

## Machinery.

The power required for a tea factory is generally calculated at from 8 to 10 H.P. for every roller installed, which includes the running of the drying and sifting machines, shafting and fans. Further, it is estimated that a full size, 36 inch roller is required in respect of every annual output of 65,000 lbs. of made tea so that the factory will be fully equipped. Many factories, however, are only equipped with one roller for every 80,000 lbs. of made tea, which is generally inadequate. It is usual to allow one roll-breaker to 2 full-sized rollers, but in large factories the proportion can usually be reduced to 2 roll-breakers to 5 rollers.

The following is a list of machinery which would be required for a factory with capacity of 400,000 lbs. of made tea per annum:—

- 3 Jackson/Marshall 36 in. Circular Rapid Rollers, working capacity 300 lbs. per charge.
- 1 Walker's 32 in. "Economic Roller," working capacity 250 lbs. per charge.
- 2 Roll-breakers, 12 feet long.
- 2 Drying Machines, working capacity 90 to 100 lbs. each per hour.
- 1 Walker's 4 tray Sifting Machine.
- 1 Michie 2 tray Sifting Machine.
- 1 Double Cutting Machine, $\frac{1}{4}$ in. cells.
- 1 Packing Machine.
- 2 50 H.P. Crude Oil low-pressure Engines.

(Where water power is available a Pelton wheel may replace one of the engines).

The factory should be equipped to turn out one-third more than the average daily output so that an estate with a crop of 400,000 lbs. should have a factory capable of dealing with a crop of 600,000 lbs. of made tea per annum. In one mid-country district 40 per cent. of the crop is obtained between July and December and 60 per cent. between January and June. In the rush season the factory may have to work day and night, but only for a comparatively short period and if withering accommodation and machinery is insufficient.

### Yields.

It is estimated that an area planted from seed at stake will produce a crop of from 300 to 400 lbs. of made tea per acre in the fourth year from planting. One mid-country estate actually produced 600 lbs. of made tea per acre in the fourth year from an area of really good land.

The average yield of made tea on the older areas is between 500 and 525 lbs. per acre, but on one estate, which is spending as much on green manuring as it does on artificial manures, the yields average from 550 to 575 lbs. per acre per annum.

### Supervision.

On large estates it is considered that one European assistant is required for every 500 acres of tea cultivated if the various works are to receive proper supervision. On one estate, however, situated on very steep land, one European assistant is employed for every 400 to 425 acres under tea.

### Labour.

Formerly, 1 cooly per acre was required to work a tea estate efficiently, but under present-day conditions and methods 1½ coolies per acre is considered to be necessary for all works.

The proportion of men to women, including working children, is usually about equal. The standard rates of pay in the mid-country districts under the Government Wage Ordinance are men 52 cents,* women 41 cents and children (10 to 14 years) 31 cents per diem. for a 9 hour day, i.e. 8 hours actual working.

### Returns.

The all-in cost of production may vary from 55 to 58 cents per lb. of made tea on a crop of 550 lbs. per acre. This includes the cost of manuring, which is roughly 10 cents per lb. of made tea.

The average price realised for all grades during 1928/29 was about 90 cents per lb., which showed a profit of approximately 35 cents per lb. of made tea.

* 100 cents of a Rupee, equivalent to 1 shilling and 6 pence (approx.).

As a rule, the cost of production on mid-country estates is about 55 cents per lb., whilst up-country high-grown teas will cost as much as 60 cents per lb. of made tea to produce, but with correspondingly higher sale prices on account of flavour.

It is stated that certain estates in various districts are producing at a cost of 47 to 50 cents per lb., but these are heavy-yielding properties which produce a crop of 750 to 1,000 lbs. of made tea per acre per annum.

It is estimated that the cost of bringing a tea estate into bearing, including factory and machinery, in mid-country districts would be from £100 to £150 per acre depending on the cost of the land and the type of factory installed. Under such conditions, a profit of from 10 to 15 per cent. may be expected on the capital outlay.

## General.

Each day's make of tea is tested daily so that any merits or defects in the manufacture of the tea can be detected. The apparatus required for tea testing includes a set of white cups and pots, a sand glass, a stove and a small tea testing scale so that a standard weight of tea is taken for each test.

The method of testing is to bring the water up to the boil and allow it to remain on the leaf for 5 minutes only. The liquor is then poured from the pots into the cups, the infused leaf being turned over into the hollow of the lid, so that a comparative examination may be made of the samples.

Heavy blending teas are generally obtained at the lower elevations and the lighter coloured liquoring teas, with flavour, at the higher elevations.

The writer wishes to express his indebtedness to the various Superintendents of the tea estates visited for the valuable assistance and advice which was so freely given to him in connection with the cultivation and manufacture of tea as practised in Ceylon.

# RICE STORAGE EXPERIMENTS

BY

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Malaya is essentially a rice importing country since approximately two-thirds of our consumption of this commodity has to be imported annually from adjacent producing countries to which, fortunately, we have fairly easy access. Local production of rice is inadequate to provide for the requirements of the country, mainly because nearly two-thirds of the population consists of imported labourers for our rubber and tin industries—labourers who, at present, possess no facilities for the cultivation of rice.

In any country dependent, as is Malaya, on outside sources of supply for the staple food of 96% of its population, the possibility of an unforeseen shortage has always to be considered. Among proposals for guarding against any such emergency it was suggested that large quantities of padi should be imported annually and stored for milling locally as required for consumption; but the storing of rice as padi would have necessitated the erection of enormous stores and padi supplies would have been relatively more expensive than rice to purchase, handle and ship.

Moreover, the storage of rice as padi would only deal with half the problem, since Siam rice, the type of rice consumed by the Chinese and forming about half of our total import, is not obtainable in the form of padi.

Further deliberations resulted in the decision to erect an experimental store adjacent to the Department of Agriculture to test the keeping qualities of rice under controlled conditions. This store was completed in November, 1927, the dimensions being 30 × 12 × 10 feet high. It is built of brick and concrete with wooden floors raised four inches off the concrete foundations and has a corrugated iron roof. The building is divided into three self-contained compartments—

(A) Protected from rats with ½ inch mesh wire netting and well ventilated.

(B) Protected from rats and insects; closed by an air-tight door and window and only ventilated on dry days through wire gauze screens.

(C) Protected from rats and insects by wire gauze but well ventilated.

The store was thoroughly dried and ventilated for some months before being stocked with Rangoon parboiled and Siam No. 2 polished rice in sacks as sold by wholesale dealers.

Before proceeding further, it may be mentioned that under commercial conditions rice is not stored locally for more than a month or two. Consequently, local methods of storage mainly aim at keeping the rice, imported in guni bags, protected from the elements. Most small local commercial stores are merely ground floor rooms in brick and cement shop houses in which the bags are piled up to some 12 to 15 feet. The flooring is usually concrete, covered by two-inch planks, on which two or three thicknesses of guni sacking are laid before stacking the bags of rice. Ventilation is usually fair but by no means good and the stores are generally fairly cool. No particular precautions are taken to avoid damage by rats or other pests. This type of store can take some 400—600 bags of rice. At the ports there are a few large stores, and of course, the local mills have a large storage capacity.

In these notes this type of store—the ordinary commercial type—will be referred to as condition D in contrast to condition A, B and C as described above.

## Decrease in Weight of Stored Rice.

In order to determine the effect of storage on the weight of rice (weight being chiefly affected by moisture content and the incidence of pests) samples were drawn at fortnightly intervals for 22 months from each type of rice under the above described four different conditions of storage. The samples were taken at least 6 inches below the surface of the rice in the bags and were always drawn from each type of store on the same day and at about the same hour, on each occasion.

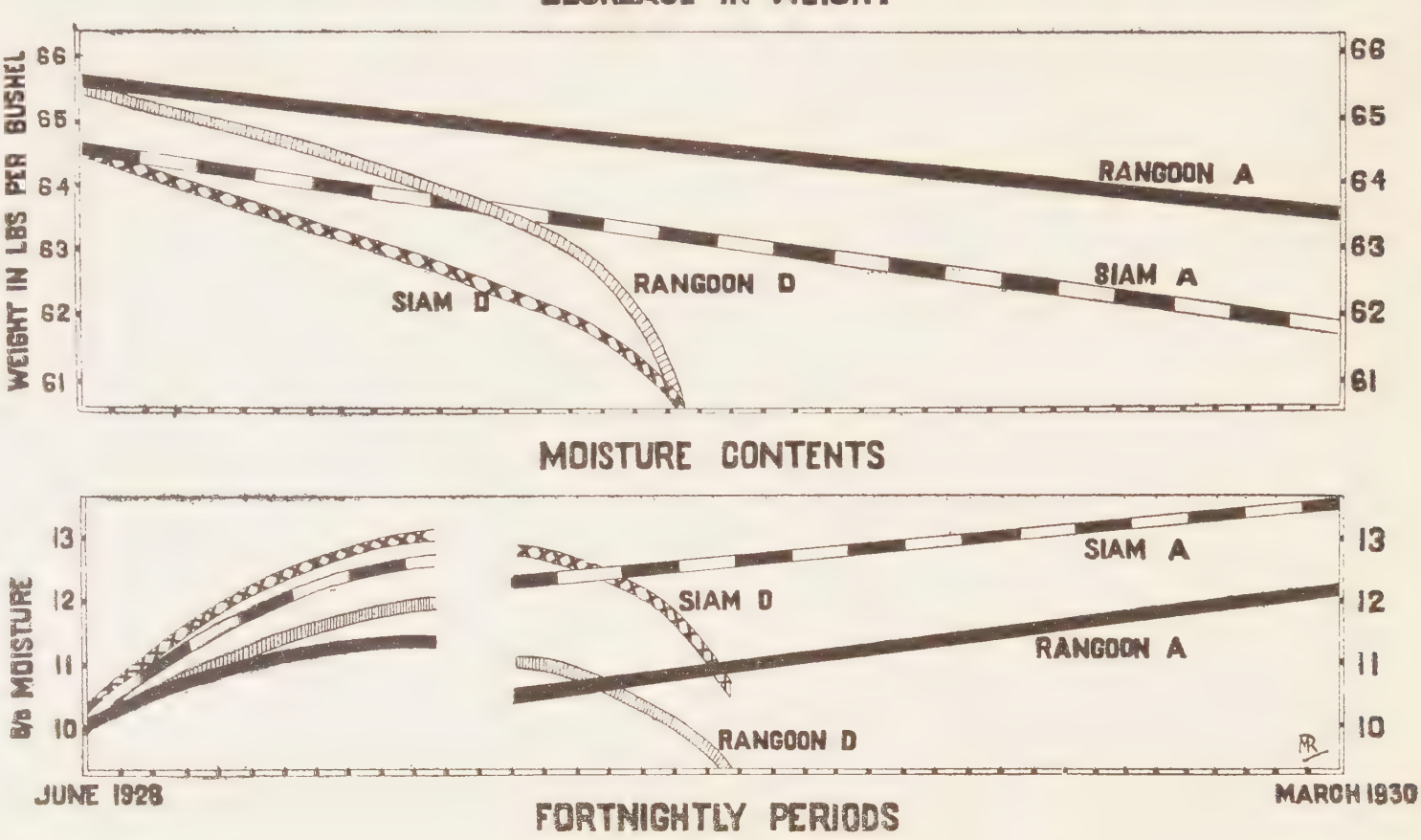
The measurements for comparison were made by using a Brauer's grain tester and tables which shew the weights of the grain samples in lbs. per bushel. This measurement was carefully taken and the error was fairly small, for in a test of the instrument with 23 readings the average deviation from the mean per reading was only .17 lbs. or .26% of the mean weight per bushel (61.05 lbs.).

If it is assumed that the rice was milled two months before the experiment commenced, the rice at the end of the experiment was two years old. Rice is frequently as much as four months old before it is retailed in this country, while it may be kept in some estates' stores for an even longer period. Furthermore, the padi from which the rice is derived may often be several months old before being milled.

The weight of rice when stored under conditions A and C was found to be fairly similar while under condition B, the loss of weight was steady and more rapid. Diagram No. 1 refers to rice stored under condition A and merely shows the trends of weight of rice per bushel and moisture content for the sake of clarity. The diagram shows that with both Siam and Rangoon rice the trends of the decrease in weight are very gradual since the total decrease for twenty months is comparatively small, being 2.2 lbs. per bushel with Siam rice and 1.3 lbs. per bushel with Rangoon rice if the averages are calculated for the first six and last six readings in each case.

The rice stored under condition B was obviously rather damp, and badly

# TRENDS OF WEIGHT AND MOISTURE CONTENTS IN STORED RICE



infested by weevils, but after drying and winnowing was still edible. The rice stored under condition D lost weight regularly but not so rapidly as under condition B until after seven months storage, when sudden deterioration set in with a great increase in weevil population, the rice being absolutely unfit for consumption after 10 months storage.

The diagram shows that under condition A, Rangoon rice is slightly heavier than Siam rice and maintains its superiority in this respect throughout the experiment. Moreover, the Siam rice appears to lose weight very slowly and with the Rangoon rice the decrease in weight is even more gradual.

**Moisture Content of Stored Rice.**

At the beginning of this experiment the moisture content was determined by heating the different samples of rice in a steam oven at 100° Centigrade until their weights were constant.

This method required a long and varying length of time, often running into 7 or 8 days and moreover, it appeared that the rice—particularly the Rangoon rice—was undergoing slight chemical change during the drying process. Hence, after seven months, the Agricultural Chemist suggested an alternative method for determining the moisture content which saved much time and did not damage the rice in any way.

An examination of the diagram shows that more moisture was extracted from the rice by the old method than by the new method of drying. This is most marked with the Rangoon rice with which the new method resulted in a drop in the moisture content of about 1% whereas the drop was only about half this amount in the case of the Siam rice.

The Siam rice appeared to give up its moisture more readily and to suffer less from overheating. No doubt some of the moisture extracted from the Rangoon rice by the old method of determination was water absorbed by the rice in the process of parboiling. The new method of moisture determination aimed at giving more comparable results from the two types of rice and consisted in drying the samples at a temperature of 105°C for a period of four hours. This method was found to be the optimum in that it did not result in any discolouring or other adverse effects on the rice, and it was considered that the maximum desiccation had taken place with the minimum of decomposition.

In the diagram, the trends of the moisture contents of Rangoon and Siam rice, as determined by fortnightly analyses, are traced.

Under all conditions of storage, the moisture content of the rices increased rapidly at first, but later the rate of increase steadied down considerably.

The diagram shows that the rate of increase in moisture content was more rapid at first in the case of the Siam rice as compared with the Rangoon rice, but that later the rates of increase were approximately equal. The diagram also shows that the Siam rice yielded more moisture than the Rangoon rice. The variations in the moisture content analyses were small and well within the limits of experimental error.

## Reaction to Weather Conditions.

Observations seemed to indicate that Siam rice reacted more quickly to changes in environment than did Rangoon parboiled rice; consequently, a simple test was made which fully confirmed the observations.

Approximately equal samples of Siam and Rangoon rice were accurately weighed and then placed in desiccators containing fresh calcium chloride. The samples were weighed carefully daily for 3 days and thereafter at intervals of a few days until each sample had reached its minimum weight. The results shewed that Siam rice lost its moisture more rapidly in the first twenty days than Rangoon rice although each type of rice lost its maximum quantity of moisture in the same period of 62 days. After this period the amount of moisture tended to increase with both types of rice.

Similarly, weighed samples of each type of rice were subjected to the same controlled conditions as regards atmospheric moisture, and it was found that Siam rice absorbed moisture more rapidly than Rangoon rice up to a period of 25 days.

Hence, it may be assumed that Siam rice reacts to changes in atmospheric conditions more rapidly than Rangoon parboiled rice.

## Eating Tests.

*Siam Rice.*—Siam No. 2 rice which had been stored for ten months under condition A (and was therefore at least 12 months old) was winnowed and compared with a sample of newly purchased rice. Before cooking the rices, the old could be distinguished from the new by being less clear in colour, very slightly floury as a result of weevil attack, by its drier appearance and by traces of ageing cracks. After cooking, the rices could not be differentiated by appearance or by taste though the smell of the steam of old rice in some cases lacked the freshness of cooked new rice. In order to test the taste of the old rice, nine Malays were given three plates of old cooked rice and three plates of new cooked rice. Not one of the Malays could discern the old from the new rice by taste, by appearance or by any other character since none of them could correctly name the order in which the plates had been arranged. Thus there was no apparent difference between the cooked Siam rice which was a year old and cooked new rice.

Again, samples of Siam No. 2 rice, which had been stored under condition A for twenty-three months, were winnowed, cooked and eaten by Malays who expressed the opinion that the rice was thoroughly good to eat. They had no idea that it was approximately two years old rice for its appearance and taste were not discernible from new rice, though the smell of the steam lacked the freshness associated with new rice.

*Rangoon Parboiled Rice.*—This type of rice, after ten months storage under condition C, was tested by Indians—eleven coolies and three clerks—in a similar manner to that used in testing the Siam rice. Again all the testers failed to

differentiate the new from the old cooked rice either by appearance, smell or taste, although the new rice appeared to the writers to taste more of the parboiling process and the steam of the old cooked rice smelt very faintly of mould.

In the uncooked condition, the old rice was easily identifiable because it was less lustrous than new rice and because it looked drier and shewed faint age cracks.

The same type of rice, after 23 months storage under condition A, was winnowed, and when cooked, was eaten readily by Tamils without any suspicion as to its age, though before cooking the differences between it and new rice of the same type were plainly evident. Thus, Rangoon parboiled rice, stored under good conditions for approximately two years, was found when winnowed and cooked, to be quite edible and hardly distinguishable from cooked new rice.

### Airtight Storage.

Siam and Rangoon rices, which had been in store for 10 months under condition A, were winnowed and placed in empty kerosine tins which had been thoroughly cleaned and aired. From each tin, samples were drawn from which the weights of the rices per bushel were determined by means of a Brauer's grain tester; the tins were then hermetically sealed.

One tin of each type of rice was opened 12 months later and the rice appeared in each case to have undergone no apparent change in appearance or in weight per bushel and when cooked, tasted thoroughly good and could not be differentiated from new rice.

Before cooking, the old rices could be discerned fairly easily from the new because the former looked drier and shewed ageing cracks, but after cooking, the differences were not discernible.

Samples of Siam and Rangoon rice have also been stored in sealed bottles under laboratory conditions for varying periods up to two years without undergoing any perceptible change; in fact, a few samples appear to be quite good after four years bottle storage.

### Fumigation and Airtight Storage.

Siam and Rangoon rices which had already been stored under condition A for 10 months were winnowed and placed in cleaned and aired kerosine tins, each containing over three gantangs of rice. Samples were drawn from each tin in order to determine the weight per bushel for each type of rice and then to each tin 5 c.c. of carbon bisulphide were added before hermetically sealing all the tins. Samples of each type of rice were at the same time placed in bottles and each bottle was treated with .5 c.c. of carbon bisulphide.

A year later, one tin of each type of rice was opened and examined and the rice tested for loss in weight, and it was found that no appreciable change in weight had taken place with either type of rice. The appearance of the fumigated rices differed slightly from rices similarly stored but not fumigated and from new rice, in shewing a pale yellow colouration which disappeared on

cooking. The cooked rices retained no odour of carbon bisulphide, the taste was satisfactory, and the rice was readily consumed by Tamils (Rangoon rice) and Malays (Siam rice).

**Insect Pests.**

The Entomologist of the Department of Agriculture examined samples of rices which had been stored for 12 months under the conditions A. B. and C.

His report indicated that insects, mainly weevils, which are by far the most destructive pest of rice, were found in varying numbers in all the samples examined, although under conditions A and C very few insects were found. Under condition B insects were fairly numerous in both types of rice, but whereas species of Rhynchota and Silvanus (*S. surinamensis* and *S. advena*) predominated in the Siam rice, the predominant insect in the Rangoon rice was *Calandra oryzae*, the common rice weevil. Possibly the prevalence of weevils in the Rangoon rice can be explained by the fact that the Rangoon rice, in the bags, was always found to be approximately .5°F. hotter than the Siam rice, and this slight difference in temperature may have produced a damper atmosphere which favoured the multiplication of weevils.

No entomological examination of rice stored under condition D was made, but fortnightly observations shewed that under this condition, both rices were much more severely infested with pests, chiefly weevils, than rices stored under conditions A, B and C.

Moreover, while Siam rice appeared to attract weevils at an earlier stage in storage than did Rangoon rice, ultimately the Rangoon rice shewed the higher infestation.

By winnowing the rices which had been subjected to all conditions of storage for 12 and 23 months respectively, it was found possible to reduce the number of insects in the rice to negligible quantities with very little reduction in the volume of the rice except when stored under conditions B and D, in which cases the damage occasioned by pests was considerable. Thus, under well ventilated conditions, both types of rice suffered less severely from pests than rices stored in poorly ventilated and consequently damper conditions.

**Mycological Examination.**

Samples of rice which had been stored under the varying conditions A, B and C for approximately 12 months were examined by the Mycological Division. Only those rices which had been stored under condition B were reported to smell mouldy, although even in this case no definite fungus was found. The rices stored under conditions A and C were free of fungus and did not smell mouldy. The rice stored under condition D was not examined as it was obviously mouldy and clumped by fungus strands.

After approximately 23 months of storage in conditions A, B and C, the remarks already made were still applicable to the rices kept under the various conditions of storage except that the Siam rice under condition C smelt slightly mouldy. Thus, only those rices which were stored under poorly ventilated conditions became mouldy.

## Vitamin "B" Extract.

As regards the nutritive qualities of stored rice, it is the general opinion in Burma that rice stored for longer periods than 4—5 months loses some of its nutritive properties and some authorities even express the opinion that beri-beri is not due so much to polished rice as to mouldy polished rice. We doubt if this theory has any medical support and a preliminary examination of 12 months old rice by Dr. Rosedale of the Medical College in Singapore indicated that there was no material difference in the Vitamin B extract of old and new rice. Moreover, Dr. Rosedale inclined to the opinion that little material gain would result from a chemical study of the ageing of rice stored for periods up to 18—24 months.

Dr. Kondo, an eminent authority on rice storage in Japan, has shown that the Vitamin B content of rice, stored for four years in airtight containers or in an atmosphere of carbon dioxide remains unchanged. (Berichte des Chara Instituts 1930).

## General.

While some authorities in Burma maintain that it is not possible to store rice with safety for more than 4—5 months, there does not appear to be much unanimity in that opinion for some of the largest millers in Rangoon have been known to store large quantities of rice for 6—8 months. The length of time over which rice can be stored in Burma appears to depend largely on the period of the year during which the milling is done, since rice milled between April and September, that is when the padi is dry, is said to be the best rice for storage purposes and this is in accordance with expectations, because rice which is well dried will undoubtedly suffer less from pests than rice containing a high percentage of moisture. The keeper of one large store in Rangoon stated that, if necessary, he could store rice for a year in good condition, and a Chinese merchant also expressed the opinion that rice would keep better in the equable climate of Malaya than it does in Burma.

While some of the rice mills in this country have fairly large rice storage capacities, rice is only stored therein pending distribution. The period of storage rarely exceeds 3—5 weeks at the outside, though during the rice shortage in 1920—21, rice was kept in stores for a considerably longer period, in one case for over six months.

Similarly, the rice merchants in Malaya do not as a rule store imported rice for more than a month or two at the outside. All their stores are merely designed to protect the rice from the elements, little or nothing being done to prevent ravages by rats or insects.

## Recommendations.

For the satisfactory storage of rice for periods up to two years, stores must be designed carefully to ensure (a) good ventilation, particularly when the air is dry, (b) dryness, (c) coolness, and (d) protection from vermin. The rice should be thoroughly air-dried before being stored so that its moisture content is less than 12% and preferably 10%.

If storage provides all the above mentioned conditions, the problem of protecting the rice from insect pests need cause no grave concern, since if insects are ultimately present—as they will be to a limited extent—they can be removed by winnowing or by washing the rice before it is cooked for food. (Rice eaters habitually wash their rice before it is cooked.) At the same time, where the destruction is required of pests already affecting the rice before it is stored, such destruction can be effected either by fumigation with carbon bisulphide or by exposing the rice to a dry heat which should not exceed 105°C. for a maximum period of four hours—the optimum temperature and a period of exposure being determined by experiment—though a lower temperature would probably be effective.

Normally, rice is more easily handled when stored in bags, but it might be found feasible to utilise airtight storage in large bins or silos either in bags or in bulk. For airtight storage the rice before storage should be well air-dried—preferably by artificial means—and then kept cool. If the rice is intended to be stored for long periods, the airtight containers, if very large, should be provided with facilities for fumigation as an additional method of combating insects.

**Conclusions.**

1. Under ordinary local commercial storage conditions, rice is scarcely edible after some eight months storage. It could, however, if well dried and winnowed and then washed, be used for food in case of a rice shortage.

2. Under rat proofed and well ventilated conditions, rice may be stored in quite good condition for two years. It should, however, be winnowed before cooking.

3. Siam rice loses weight more rapidly than Rangoon rice because it is more severely attacked by weevils in the earlier months of storage.

4. Under well ventilated conditions the moisture content of Siam rice increases more rapidly for some four months than does that of Rangoon parboiled rice.

5. After some four months, the rate of increase in moisture content of both rices is approximately equal and gradual, but the Siam rice has, constantly, a moisture content about 1½% higher than Rangoon rice.

6. Under airtight conditions, rice can be kept in good condition for two years (probably much longer).

7. If fumigated with carbon bisulphide at the rate of 5 c.c. per 4 gallons (18 litres) rice can be stored in airtight containers for two years (probably much longer). The carbon bisulphide fumes tend to impart a pale yellow tinge to the uncooked rice. Less of the fumigant would certainly be sufficient to keep the rice free from insect attacks.

8. Rice (in small quantities) can be kept for two years in airtight containers to which one ball of naphthalene has been added per gallon of rice.

9. A preliminary examination shewed no material difference between the Vitamin B extract of rice stored for 12 months in good conditions and that of new rice.

# THE AMERICAN MARKET FOR TUBA ROOT
## (Derris elliptica)

BY

R. C. Roark,

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Injurious insects in the United States cause a loss that has been conservatively estimated by economic entomologists at $2,000,000,000 a year. For combating these pests large quantities of insecticides are used. Exact statistics are not available, but not less than 30,000,000 pounds each of lead arsenate and calcium arsenate are yearly consumed. In 1928, the importation of Pyrethrum flowers into the United States amounted to more than 11,000,000 pounds, valued at nearly $2,500,000. Nicotine and other insecticides are used in great amounts also. The market in the United States for insecticides has grown rapidly in the last 20 years and may be expected to continue to grow.

The roots of certain species of Derris have been known for many years to possess valuable insecticidal properties, but Derris has been used only to a limited extent in the United States. This has been due to ignorance concerning its value in controlling specific pests, to fear of its reported toxicity to man and domestic animals and to a lack of knowledge concerning its chemistry. Only recently have the constituents of Derris root been isolated in pure form and carefully studied. A Japanese chemist, Nagai,* isolated rotenone, its most potent insecticidal principle, as early as 1902, but it is only within the past five years that any appreciable progress has been made in our knowledge of the chemical nature of this compound. The structure of rotenone is now being investigated by chemists in Japan, Germany, England, and the United States.† It is reasonable to expect that their efforts will eventually reveal the structure of the rotenone molecule. Whether rotenone can ever be synthesized is a question that must remain unanswered for the present.

Rotenone is a white crystalline material having the empirical formula $C_{23}H_{22}O_6$, and a melting point of 163° centigrade. It contains 1 keto group and 2 methoxyl groups. It is extremely insoluble in water, very slightly soluble in petroleum ether, kerosene and other petroleum hydrocarbons, slightly soluble in methyl, ethyl, n-propyl and n-butyl alcohols, soluble in benzol and acetone and readily soluble in chloroform, ethylene dichloride and trichloroethylene.

At the April, 1930, meeting of the American Chemical Society, W. M. Davidson, an entomologist of the United States Department of Agriculture,

* J. Chem. Soc. Tokyo, 23 : 740, 1902.

† LaForge and associates, Jour. American Chem. Soc., 51 : 2574, 1929, and 52 : 1088, 1091 and 1102, 1930.

reported that 1 gram rotenone in 300 litres of water (a dilution of 1 in 300,000) effectively controlled the bean aphid (*Aphis rumicis*).

At this same meeting Dr. D. E. Buckingham, a veterinarian of Washington, D.C., presented a paper reporting results of feeding rotenone to dogs, cats, sheep, chickens and other domestic animals. A dog when fed pure rotenone at the rate of 1 grain per pound of body weight manifested no visible symptoms. Chickens that had been fed several grains of rotenone each were unaffected. These chickens were afterwards eaten without causing any ill effects. It may be concluded from these experiments that pure rotenone, separated from the resinous substances and other constituents associated with it in Derris root is harmless to mammals and to chickens when taken by mouth.

Rotenone thus appears to be an ideal insecticide, as it is highly toxic to insects but non-poisonous to man and domestic animals when eaten by them.

Rotenone is also effective as a stomach insecticide. Caterpillars feeding upon vegetation sprayed or dusted with rotenone are killed. Tests indicate that rotenone is more toxic than lead arsenate as a stomach poison to some insects. Rotenone is thus potentially one of the most valuable insecticides and it should be much in demand when it becomes better known.

Derris root varies widely in its rotenone content, the proportion ranging from a few tenths of a per cent. to 5.5 per cent. in commercial shipments. Instead of selling Derris on the basis of ether extract dealers would do well to offer it on the basis of rotenone content. While the ether extract of Derris root includes any rotenone present, it also includes a number of other compounds of less insecticidal value. Clark* has isolated and purified a number of the constituents of Derris root other than rotenone. These include toxicarol, ($C_{23}H_{22}O_7$, yellow crystals, melting point 218—220°C.); tephrosin, ($C_{23}H_{22}O_7$, white crystals, melting point 198°C.); and a compound of the formula $C_{23}H_{22}O_6$, (white crystals, melting point 171°C.) Tests so far made with these compounds against insects show that they are less effective than rotenone as contact insecticides.

### Determination of Rotenone in Derris Root.

The following method has been employed in the Insecticide Division laboratories in assaying commercial Derris root for rotenone:

One hundred grams of dry ground root (20 mesh) is completely extracted in a Soxhlet apparatus with ether. The extract is concentrated to about 25 cc. and transferred to a 125 cc. flask. The original container is washed with three 5 cc. portions of ether, and the combined extract and washings are concentrated to 25 cc. The extract is then set aside for one day to allow the rotenone to crystallize. In order to hasten crystallization the flask is occasionally scratched. The rotenone is then filtered upon a tared Gooch crucible containing a filter paper disc, washed with about 10 cc. of ether in small portions, dried, and weighed.

* Science, 71 : 396, 1930.

An extract of Derris root would be more acceptable to the trade than crude roots, and the manufacture of such an extract might well be undertaken at the place where the roots are grown. By selling a Derris extract instead of the roots the cost of transportation would be reduced to approximately one-fourth the present rate, and by sending the extract direct to the United States instead of by way of European ports a further reduction in costs would be effected.

We have found acetone to be a convenient solvent for extracting, on a large scale, the rotenone and other constituents of insecticidal value from Derris root. The coarsely ground roots are macerated with the solvent for 24 hours, after which the solution is drawn off, the acetone distilled, recovered and allowed to repercolate through the roots. This is all done in a closed system and very little of the solvent is lost. About 20 to 25 pounds of solid extract are obtained from 100 pounds of high-grade roots. Ether may be similarly employed, but the fire hazard attending its use is much greater than with acetone. Benzol is used by Japanese manufacturers of Derris insecticides in extracting the rotenone.

**Rotenone Occurs in Other Plants.**

The Insecticide Division has been making a survey of tropical fish poisoning plants for the purpose of finding materials of value as insecticides. Clark* has shown that the South American plant "cube" (pronounced coó-bay) contains 7 per cent. rotenone. This is a higher percentage of rotenone than has been reported for Derris root. Killip† has identified "cube" as *Lonchocarpus nicou* (Aubl.) D.C. Tattersfield, Gimingham and Morris‡ had previously reported other species of *Lonchocarpus* from British Guiana to contain tuba-toxin (another name for rotenone). Other plants reported to contain rotenone are *Milletia taiwaniana Hayata*§ *Mundulea suberosa Benth*‖ and *Ormocarpum*¶.

Species of Derris other than *elliptica* have been shown to possess insecticidal properties which are doubtless due to rotenone. These species include *D. chinensis, malaccensis, philippinensis, polyantha, thyrsiflora* and *uliginosa.* The first named species, *D. chinensis,* has been reported by Takei** to contain 6 per cent rotenone.

It may be possible, by careful selection and breeding, to develop a variety of Derris containing much more rotenone than the species now commercially available. Efforts along this line should yield generous returns.

It would seem that *Lonchocarpus* should thrive in the Federated Malay States and adjoining country, and the introduction of this plant is suggested. At present the roots of *Lonchocarpus* species are not available in commercial quantities, but potentially they are a more valuable source for rotenone than is Derris.

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* Science, 70 : 478, 1929.

† Jour. Wash. Acad. Sci., 20 : 73, 1930.

‡ Ann. Appl. Biol., 13 : 424, 1926.

§ Atsumi and Shimada, Yearbook of Pharmacy 1924, p. 209.

‖ Greshoff, Ber. deut. Pharm. Ges. 9: 215, 1899.

¶ Greshoff, loc. cit.

** Biochem. Z. 157: 1, 1925.

**Possible Uses for Rotenone.**

Efforts are now being made in the United States to find a substitute for lead arsenate for spraying against the codling moth and other orchard pests. Field tests will be made during the summer of 1930 with rotenone to test its efficacy as a stomach insecticide. If rotenone proves successful in controlling chewing insects a large demand for the product may be expected. The high potency of rotenone as an aphiscidal spray is already established, and there is a large market for it as a contact insecticide. When the desirable insecticidal properties of rotenone become generally known there will be no difficulty in marketing large supplies of it in the United States.

# Selected Article.

## SELECTION OF ROBUSTA COFFEE.*

Mr. Hille Ris Lambers—(See "De Bergcultures" Vol. 3 (1929)—page 1924)—delivered a very instructive lecture on the selection experiments made in Java with Robusta Coffee; of which the following is a review.

The first thing to which attention should be drawn is that fact that the Robusta fields, now in existence in Java, are a mixture of many greatly different types, many of which have come into being as a result of hybridization with Uganda, Quillou and Canephora coffee. In breeding experiments, the chief object is to obtain races which are distinguished by their large yields, power of resisting diseases and pests, good quality of the beans—(size, evenness, colour, flavour and taste)—and easy workability (removal of silverskin etc.). Breeding consequently has to start by selecting those trees in the field that possess these properties in as favourable as possible a combination so that they can serve as mother trees for further breeding. For that purpose, all trees in the field that are found to possess especially advantageous properties are marked with indelible numbers and all observations made are accurately recorded. In order to obtain reliable information on the yielding capacity of these trees, yield records have, of course, to be kept for a number of years.

Descendants of the selected mother trees may be obtained by either vegetative propagation—(budding or grafting)—or by growing from seed.

In the case of vegetative propagation, the properties of the mother plant, and also its power of resisting diseases and pests, are in most cases retained by its descendants. But the character of the stock on to which they have been grafted may make itself felt and in this respect valuable experience has already been obtained in Java. For instance, *Coffee excelsa*, formerly frequently recommended for this purpose, has generally proved to be less serviceable, trees budded on to this stock frequently suffered from too heavy bearing in the first few years. Hybrid 12401 of Robusta x Quillau recommended by Crainer, seems to be serviceable for general use. Some pure Robusta races too, have supplied good stocks. It may also be advantageous to use seedlings from good mother trees as stocks. When a combination of stock and scion does not give satisfactory results, there remains the possibility of sawing off the tree trunk below the point of union and of letting a shoot grow from the stock and in that way obtaining a new tree with, to some extent, satisfactory properties.

When grafted plants have been obtained from buds of a common mother tree, and planted in different spots, careful and long observation will make it possible to come to a reliable conclusion as to the extent to which the good properties

* Translated from "Der Tropenpflanzer," Vol. 33, No. 2, Feb., 1930.

of the mother tree had been due to external conditions, for instance, to especially suitable soil. It can then also be determined for what climatic and soil conditions the clone is best fitted.

When a mother tree is propagated from seed, it should be remembered that with Robusta coffee this usually results from cross pollination and that consequently the progeny of any tree in the field may be from different fathers and the properties of the mother tree may be combined in the most different ways with those of the father tree and with those of the ancestors of both parents. It has, however, been determined by tests that in the case of crossings of different coffee species and varieties, the properties of the mother tree are more prominent; for instance, in a cross between *Coffee robusta* (female) x *C. arabica* (male) the resulting progeny is more like *C. robusta* and in a cross between *C. arabica* (female) x *C. robusta* (male) more like *C. arabica*.

A more even field of young trees can, at any rate, be obtained when cross-pollination is excluded. With a mother tree standing in a field this can be done by building a cover of a close-meshed gauze round it. By this method, however, but few good seeds have been obtained. Better results are obtained by watering the mother-tree abundantly in the dry season when normally no flowers are formed. The effect of this is that about a week later flowers open on that tree and they can, of course, be pollinated only with pollen from that particular tree; care should, however, be taken to remove all flowers opening on that tree after the rains have started as they are liable to be pollinated with outside pollen. In practical work, the procedure usually is to plant, in an isolated position, a separate field, containing only vegetatively propagated descendants of a single common mother tree. In that way, a great quantity of seed from the same clone is more easily obtained. Seedlings grown from such seed may still show considerable difference in properties and only repeated selection will eventually produce seed that will be more or less true to type.

Apart from this, crossings have also been made artificially between good parent trees; those trees among their progeny so obtained that proved to possess good properties, are to be multiplied by vegetative and by sexual propagation.

At present, however, it is not considered advisable to graft on a large scale; many questions, such as the behaviour of such trees at an advanced age and their superiority over trees grown from selected seed, have not yet been sufficiently investigated. All estate directors are, however, advised to make an immediate start with budding experiments. Under certain conditions graftings may be made in existing fields. For instance, it may prove advantageous to cut down poorly yielding trees of Quillou in a damp environment or of Canephora and to graft a bud from a high yielding tree on to a shoot growing from the stump. Such experiments also supply experience as to what types grow best on any particular estate under local climatic and soil conditions.

From the above it may be concluded that coffee selection is energetically and purposefully conducted in Java and it may be expected that these investigations will be of increasing practical benefit in the cultivation of coffee.

# Abstracts.

## BUDDING AVOCADO SEEDLINGS.*

The operation of budding is simple, but must be carried out with unusual care and attention to every detail to ensure success.

Seedlings to be used for budding should be kept in a thrifty, growing condition. They may be budded any time during the season when the sap is flowing freely, after they have attained a diameter of one-half inch. Usually this occurs early in the spring. For budding at this time, well-matured wood from the previous season's growth may be used. After active growth has commenced, suitable buds are not available until new growth has hardened, usually by the latter part of November. At this time budding can again be commenced and continued until late in the autumn. A certain percentage of the buds inserted in autumn will push out and make some growth and will require extra protection during the winter. Only buds put in very late autumn can be counted on to remain dormant until spring.

Ordinarily wood that is well matured with fairly plump buds, that is, wood not hard and yet which does not snap on bending, furnishes the best material for buds. Intimate knowledge of the peculiarities of each variety comes only with practice and observation.

Shield budding, such as is used in the propagation of citrus and deciduous fruits, is the common nursery practice. A "T" incision is made within 2 or 3 inches of the ground, preferably on the south side of the seedling. The bud is cut in the shape of a shield not less than an inch and a quarter in length, and is pushed gently into position. The stock should be in such condition of growth that the bark will slip readily, and will not require lifting by the knife blade, otherwise it is too dry to be used successfully.

The knife blade used for cutting buds should be thin and should be kept at a razor edge. The cut should be made as parallel to the surface of the stick as possible with a single sliding motion: much of the success of budding depends on having the cut uniform, smooth and straight.

After insertion, the bud is immediately wrapped, beginning at the top and working down. Budding cloth is recommended, provided a hard wax is used in its manufacture which will not melt and injure the bud in hot weather. A wax composed of one pound of beeswax and one quarter of a pound of resin is satisfactory.

About three weeks are required for the buds to unite with the stock, during which period they should be examined and the wrap loosened to prevent binding.

* Reprinted from "Farming in South Africa", Vol. V, No. 49, April, 1930.

Reference: Avocado Culture in California (Bul. 365) University of California. Manual of Tropical and Sub-tropical Fruits—Popenoe.

The top should be pinched back at this time in order to start the bud into growth. From 6 to 8 weeks after budding the wraps may be safely removed. After another month of growth the seedling should be cut back still further, leaving some foliage to take care of the sap flow. The seedling top should not be cut off until the bud has grown at least two feet.

Sometimes if the top is pinched back, as suggested above, to force the bud, it has been found that it is extremely difficult to get the seedling to grow again, in the event of the bud having failed to take, and a second attempt being contemplated. Where this is likely to happen, it is best not to stop the seedling until the bud is actually shooting.

It must be pointed out that it requires considerable skill and patience to bud avocados successfully. Nurserymen in the Transvaal and also in California consider themselves quite fortunate if they obtain a 30 or 40 per cent take.

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## DERRIS OR TUBA ROOT.*

For many years past the people of the Phillipine Islands, Southern China and the Federated Malay States, Borneo and Sumatra, have been using the roots of the low-growing shrub known as *Derris elliptica* for killing fish and insects and as the source of an arrow poison. Some ten or twelve years ago some of the root was brought to America for trial as a possible valuable insecticide. Within the past four or five years Derris has proved to be a very effective poison for a considerable variety of insects. Green apple aphis and the nasturtium aphis can be effectively controlled by spraying with the ground root at the rate of one pound to 20 gallons of water. It destroys mosquito larvae when applied at the rate of one pound to each 1,000 gallons of the water in which the larvae are present. Many other insects are also amenable to the poison contained, but particularly fleas, lice, house flies and the larvae of the warble fly and it is for these latter that Derris is chiefly used at present.

The powder produced by grinding the roots is brown in colour and contains as the active principle, a substance called "Rotenone", $C_{23}H_{22}O_6$, a name which is derived from the Japanese name for the derris plant (viz. Roten.).

No doubt Derris will become more widely used as it becomes better known and after it has received more extended trials as to its effectiveness against other insects. It has already shown itself capable of destroying a great variety of insect life. Reasonable cost, ease of securing and ample supply will be the other factors which will determine to what extent it will become utilised.

Several preparations are on the market under various trade names which contain extracts of Derris as their active ingredient. 'Pulvex' and 'Derrisine' are examples of such.

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* Reprinted from "Insecticides, Fungicides and Herbicides," by H. L. Fulmer, B.S.A., M. A., Bulletin 351, April, 1930, Ontario Department of Agriculture.

# Review.

## A GUIDE TO RUBBER ESTATES BOOK-KEEPING AND ACCOUNTS.

BY

E. D. Butler, A.C.A.

*Singapore, Printers Ltd., 1930. 74 pp. and Indices.*

As the Author states in the Preface, this volume does not purport to be an instructional book on the theory and practice of book-keeping. The object of the book is to provide an authority to which planters can refer when dealing with matters of book-keeping and accounts on their estates, or when called upon to keep their own estate accounts. The arrangement and conciseness of the contents of the fourteen chapters and the provision of a General Index and Index of Forms and Specimen Rulings achieves the object in view.

The reader is taken through the routine of the double entry system, separate chapters being devoted to the Cash Book, Journal, Check Roll, Ledger, Trial Balance and Balance Sheet, and Profit and Loss Account, interspersed in suitable places with chapters on Coolie Deposits etc., Monthly Statement of Estate Expenditure, Manager's Account Current, Capital and Revenue, Costs, Crop Book, and Office Routine and Filing.

In these days, when cost of the production and market price of rubber are almost synonymous terms, rigid economy in production is essential. Without an adequate system of book-keeping it is impossible to check waste and to realise where further economy is possible. Mr. Butler's book outlines a satisfactory system of standardising accounts which should make it possible for a manager to exercise perfect control over the area under his charge.

D.H.G.

## MALAYAN AGRICULTURE AT THE INTERNATIONAL MARITIME AND COLONIAL EXHIBITION, ANTWERP, 1930.

The British Government Pavilion, designed by Sir Edwin Lutyens, occupies a commanding position upon an angle of the old city fortifications of Antwerp, and is reached by two bridges spanning the moat.

Malaya shares the Colonial Section of this Pavilion with the Gold Coast and Nigeria and His Majesty's Eastern African Dependencies, and occupies an area of 1,690 square feet, or four bays, on the angle facing visitors immediately on their entrance by the East door.

The agricultural exhibits occupy three bays—the fourth being concerned with mining, forestry and native arts and crafts.

The first bay is devoted to oil palm products, tea, coffee, various minor products, coconut products, tapioca, tuba, pineapples and fibres; also to the exhibit of the Rubber Research Institute of Malaya, comprising the scientific side of rubber preparation and the pathology of rubber. The exhibits include the various types of tapping-knives and gouges, metrolacs, hydrometres, the preservatives, coagulants and anti-coagulants, and specimens of latex, latex serum, coagulam and wet sheet. Under pathology of rubber is included specimens of defective rubber and specimens illustrating the various diseases to which the rubber tree is prone, together with a large number of photographs and water colours.

Of the other agricultural products, chief prominence is given to oil palm products and pineapples. These two exhibits are accompanied by special graphs of export statistics, prepared by the Department of Agriculture and displayed in gilt frames. Whole pineapples are displayed in jars, surrounted by pyramids of tinned pineapples under as many packings and labellings as practicable. Invitation cards to view the pineapple exhibit were sent to about one thousand leading provision merchants.

The oil palm and coconut exhibits are accompanied by soaps and other manufactures to illustrate their industrial applications.

The second and third bays contain a comprehensive exhibit staged by the Rubber Growers' Association, illustrative of the leading industrial applications of rubber, viz. Rubber flooring, stair-covering and wall panelling; rubber flowers; sponge rubber and pneumatic mattresses and upholstery; rubber in motor car construction; Wilkinson Process; rubber in machinery; rubber roadways; rubber Wellingtons; domestic appliances; rubber in combination with precious metals; and plantation sole crepe for footwear.

The centre of this section is occupied by an attractive dioramic back-cloth shewing a plantation scene, faced with an exhibit of raw rubber in all its forms and a working model of a battery of estate machinery. At a special counter in one corner fitted with the necessary machinery, an expert gives daily five demonstrations of soleing shoes with plantation crepe, embodying the special feature of employing latex as an adhaesive. Invitations were sent to some 3,000 members of the Belgian shoe trade, inviting them to attend these demonstrations and a very gratifying degree of interest has been evoked.

The walls of the bays are suitably decorated with photographs, flags and arms of the Federated Malay States and arms of the various States.

The effect of the whole stand is colourful in the extreme and the general lay-out has undoubtedly achieved its main object in impressing upon the visitor some notion of the tremendous fertility of Malaya and its multitudinous resources.

A portable projector is proving highly useful for shewing views of Malayan scenes and industries. Each picture is projected on a frosted glass screen for about five seconds, allowing time for the passers-by to read the caption, but sustaining the movement sufficiently to attract attention.

In addition to a supply of the Agency's regular publications, the stand is distributing two pamphlets specially prepared for exhibition, viz. " Agriculture," (being an abridged edition of the regular pamphlet prepared by the Department of Agriculture), and "Some Notes on the Preparation of Rubber, its Defects and Diseases," compiled by the Rubber Research Institute. These, together with the Malayan Information Agency's brochure on Pineapple Cultivation in Malaya, (also prepared by the Department of Agriculture) have been printed in English, French and Flemish.

There was such a rush for pamphlets in the early days of the Exhibition that considerable difficulty was experienced in controlling distribution. Later, precautions were taken and only genuinely interested enquirers were supplied.

The proportion of popularity of the booklets seems to be approximately 60% " Agriculture," 25% "Pineapples," and 15% " Notes on the Preparation of Rubber." The demand for Flemish, French and English versions of each are probably in about the same proportion. It must be remembered that the pineapple booklet, unlike the others, is illustrated; and it should be added that the majority of those taking the Rubber Research Institute's pamphlet, who are mainly technical enquirers or serious students, are emphatic in its praise.

The Publicity Officer of the Malayan Information Agency—from whose report for the first two months of the Exhibition the present account is written —comments on the results to date. He points out that as the Exhibition has only been running for two months, it is early to attempt such an estimate. It must suffice, therefore, to indicate the tendencies up to the present.

Results in the case of all exhibitions fall into two divisions—general educative propaganda and actual business enquiry.

Regarding the former division, check figures of the number of visitors are

in themselves a sufficient answer. On ordinary week-day mornings the attendance is moderate, as might be expected, though visitors at this time of day are generally of a fair intellectual level and provide the bulk of the trade enquiry. In the afternoon, the numbers are usually increased about tenfold. On Saturdays, Sundays and Festival days, the crowd swells to truly enormous dimensions, and on more than one occasion the check figures have shown that the public has been passing through the pavilion, between the hours of 2.30 p.m. and 6 p.m. at a steady rate of nearly 20,000 to the hour. Although the majority of such large crowds are not taking an intellectual interest in the exhibits, it seems permissible to hope that some thousands of people, when the name of Malaya comes to their attention in the future, will connect it with the wide diversity of products they were shown on the Malayan Stand at Antwerp. Moreover, the fact that, apart from Malaya, the only territories exhibiting in the Colonial Section are the Gold Coast and Nigeria and His Majesty's Eastern African Dependencies, must surely tend to concentrate public attention upon Malaya in a greater degree than would have been the case had a larger number of countries been represented.

It seems to be universally admitted that the Malaya Stand is particularly noteworthy as being bright, decorative and informative, and the officials both of the British Commission and the Exhibition Committee have been most emphatic in its praises. The indications at present are that Malaya will derive considerable benefit—both direct and indirect—by participation in this important exhibition.

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## AGRICULTURAL SHOWS IN AUGUST, 1930.

### Agri-Horticultural Show, Kuantan.

A Show for the Districts of Pekan and Kuantan was held at Kuantan on the 28th August, 1930. The Committee decided to dispense with entrance fees and this factor, combined with careful arrangements for collecting and forwarding exhibits, resulted in a very satisfactory number of entries, many of which attained a good standard of quality. In the Cereals Section there were over 1,500 exhibits of padi and rice together with a good collection of maize. The Gold Medal presented by His Highness the Sultan of Pahang, for the best exhibit of padi, was awarded to a competitor from Pekan District for a sample of the pedigree strain Radin 2. The Fruit, Vegetable and Arts and Crafts Sections were also good, a creditable share of prizes for vegetables being secured by exhibits from school gardens. The Vegetable Section was well supported by Chinese as well as by Malays, though the latter predominated among the winners of prizes for fruit. The Livestock Section included a number of cattle and buffaloes with some sheep and goats.

The Show was opened by His Highness the Sultan, assisted by the Honourable the British Resident of Pahang. The numerous visitors and exhibitors took a keen interest in all sections and also in the instructional exhibits prepared by the Health Department, the Rubber Research Institute and the Department of Agriculture.

### Agricultural Show, Perak North, Taiping.

An Agri-Horticultural Show was held at King Edward VII School, Taiping, on the 23rd and 24th August.

The Show, which was opened by H.H. the Sultan of Perak, was fairly well attended, especially by Malays and Chinese, who displayed considerable interest in the Departmental exhibits. Unfortunately there was heavy rain for most of the afternoon on both days, consequently the Show was not so well attended as usual.

The exhibits in the agricultural section were of good quality although the entries in some sections were not so numerous as usual. Fruits and vegetables were well represented and the collections of vegetables shown from School gardens were good. In the Cereal Section there were a large number of exhibits of both padi and maize.

The Poultry Section was well supported and contained exhibits of local ducks, geese and fowls of mixed breed.

The Horticultural Section was disappointing, there being only two or three exhibits staged; there was, however, the usual fine display of vegetables and flowers from Maxwell's Hill.

The Arts and Crafts Section was well supported and there were some fine examples of basketry, embroidery and other work, including silver-ware.

Educational exhibits were staged by the Health branch of the Medical Department, the Rubber Research Institute and the Department of Agriculture. There was also a display of articles made by convicts at the Convict Establishment, Taiping.

The Rubber Research Institute exhibit dealt with rubber diseases, faults in the preparation of rubber; soils and manures.

The Department of Agriculture staged exhibits of Tea from the Government Plantations at Serdang and Cameron's Highlands; oil palms—fruits and oils with explanation of their uses; faults in the preparation of copra; pure high yielding strains of padi; insect pests of padi and the coconut palm; diseases of the oil palm and destruction of rats. Departmental publications were also obtainable.

## FROM THE DISTRICTS.

### The Weather.

Very dry hot weather continued throughout August with some showers towards the end of the month, when a break in the long drought appeared imminent.

### Remarks on Crops.

*Rubber.*—The price declined again during the month, smoked sheet from small holdings selling for $15 to $19.50 a pikul and unsmoked sheet for $12 to $17.50 a pikul. The number of untapped holdings increased slightly. More tapping coolies were dismissed, while many others were given a half share of the daily production in place of the usual daily contract rate of 12 or 13 cents per kati of dry rubber. As was to be expected, the dismissal of tapping coolies has resulted in the appearance of mouldy rot disease in some previously healthy areas where coolies dismissed from infected holdings have obtained employment.

*Padi.*—In Kedah, owing to persistent dry weather, planting is two months late and it is feared that the yield will be adversely affected. In Krian the land was being cleared, except in the mukims of Selinsing, Gunong Semanggol and part of Briah, where no water was available. In other parts of the country most areas with an adequate supply of irrigation water had been planted up by the end of the month. In many areas, however, notably in Province Wellesley, the soil was so dry that planting was impossible. In such areas nurseries have often become too old for transplanting and new nurseries will have to be sown. Consequently planting will be very late and yields will be liable to suffer.

Outbreaks of army worms, *spodoptera mauritia*, have been common in nurseries and even on planted padi under dry conditions. The caterpillars have usually been heavily parasitised and have in many cases disappeared without doing very serious damage, but in some instances hand collecting and other control measures have been necessary. As is usual in a dry padi season, other pests such as "Kutu Bruang" (the Pentatomid bug *Scotinophora coarctata*) and stem borers, mainly Diatraea and Sesamia, have also been in evidence.

*Coconut.*—The price of copra declined again to $4.50—$5.50 a pikul except in Province Wellesley where prices ranged from $6.25—$7.30. In the coastal copra-making areas nuts varied from $1.00 to $1.50 a hundred. In inland Districts prices remained about the same as in July.

Palms have continued to crop well in the Province. In Bagan Datoh District the drying up of the drains has deprived estates of their usual means of conveying nuts to the factories.

*Coffee.*—The price of coffee has now fallen to about $16—$18 a pikul. Inspite of the low price, however, a few new areas are being planted up in Pahang, while in Batang Padang District of Perak, Chinese are planting mixed coffee and rubber.

*Tea.*—An area of 500 acres has been alienated on lease for tea cultivation in Lower Perak District. It is expected that part of the land will be opened this year.

*Tobacco.*—In Province Wellesley a nursery bed has been prepared for tobacco seed obtained from the Government Experimental Plantation, Serdang, in order to provide interested Chinese small holders with seedlings for trial.

*Gambier.*—The gambier market has strengthened recently and gambier plantations in Temerloh District of Pahang have recommenced work following a long stoppage. The price of cube gambier at present is stated to be $15 to $16 a pikul.

*Pineapples.*—In Singapore pineapples have been scarce at the factories and the season may now be considered as finished.

*Fruit.*—The durian and mangosteen, crop had practically finished by the middle of the month, but supplies of rambutan, langsat, rambei and mata kuching were available in most localities. These supplies were, however, rather limited, the fruit season generally having been disappointing, probably owing to the prevailing dry weather.

In Negri Sembilan many fruit trees were in flower, but in different areas in the same district there was a great variation, some trees being in flower whilst others had a crop of fruit.

## Notes of Demonstration Stations and Padi Test Plots.

Work progressed normally on all stations and plots, except the padi test plot at Bukit Merah in Province Wellesley where planting has been rendered impossible up to the present by the prevailing drought. The Padi Inspector's Quarters, Office and Store are in course of erection on this plot.

*Kedah Rice Experiment Station.*—A new station 50 relongs* in area is being established at Telok Chengai in Kedah. Nurseries have been planted with 14 imported and 4 local strains of padi. Ploughing was in progress during the month and other fundamental work had been undertaken.

At the Kuang Test Plot in Selangor a heavy infestation of the stem borer, *Sesamia inferens,* caused appreciable damage. Attacked plants were destroyed by fire and replaced by splitting up healthy plants of the same variety, there being no more seedlings available. The padi at the Temerloh Plot in Pahang was suffering somewhat from shortage of water.

*Kuala Lipis Demonstration Station.*—Four varieties of sweet potato, two varieties of maize and a plot of Red Gourd were harvested. Yields in all cases were low owing to the drought. Local Red No. 1 for the second time proved the best of the sweet potato varieties. Two plots of Sorghum, var. Barbuda, planted early in July showed uneven growth.

## Plant Distribution.

The distribution of pedigree strains of padi to planters in Larut District was

completed. In Perak South greater and lesser yams, Natal White Horse Tooth Maize, ginger and sorghum were distributed to 41 schools and seed of *Centrosema pubescens* was given to the penghulu of Blanja while in Negri Sembilan the yams of the two above mentioned varieties and seed of sweet corn and cantaloupe were distributed.

## Home Gardens.

Home gardens are the logical outcome of school gardens and it is satisfactory to record that some school pupils are forming their own home gardens in Malacca and Province Wellesley. The Junior Agricultural Assistant in Jasin District of Malacca, who has been encouraging this development since the beginning of the year, has met with some success and induced pupils from seven schools in his district to devote spare time to their own vegetable gardens. In some cases the scholars have been able to obtain seed from the school gardens. This movement is being encouraged by the promise of prizes for the best gardens.

## Rats.

In Province Wellesley rewards were paid for 125,081 rats' tails and 35,638 poison balls were distributed. In Krian tails collected amounted to 217,431 and 28,650 poison balls were distributed.

Elsewhere the sale of rat traps at cost price has been maintained, while in Selangor a number of poisoned balls have been prepared for free distribution. In Malacca action has been taken to increase the efficiency of the rat campaign.

## DEPARTMENTAL NOTES.

### The Director of Agriculture visits Negri Sembilan.

The Director accompanied the Committee for the Extension of the Cultivation of Rice in Malaya—of which he is Chairman—on a visit to Negri Sembilan from 25th to 27th August, 1930 inclusive.

### Agricultural Advisory Committee.

A meeting of the Agricultural Advisory Committee was held at Kuala Lumpur on July 17th, 1930, at which the progress of the work of the Department of Agriculture was reviewed and certain important matters dealt with in detail. The following notes indicate the subjects considered by the meeting.

*Padi Yield Improvement.*—With the co-operation of the District Officer, Krian, efforts have been intensified this year to induce the cultivators to plant special high-yielding strains of padi obtained as a result of selection work at the Titi Serong Rice Experiment Station, Krian. The Committee was informed that hybridisation work has been added to the pure line selection work, with a view to obtaining further improved strains of padi. Work on padi selection has been extended to Malacca, where a padi experiment station has been organised, while steps are being taken to undertake similar work in Kedah.

*Manuring of Padi.*—Progress was reported in relation to investigations concerning the manurial requirements of rice, which were being carried out in specially constructed tanks. The object of this work is to determine the actual feeding requirements of padi under controlled conditions. Details were also given concerning the manurial experiments with padi in the field which are being carried out in various parts of the country.

*Coir Fibre.*—The Committee considered the possibility of establishing the local manufacture of coir fibre. The subject was investigated by the Agriculturist during his recent visit to Ceylon. From the information available, it does not appear that the establishment of the industry in Malaya was likely to prove successful.

*Re-organisation Scheme.*—A scheme for the re-organisation of the Department, prepared by the Director of Agriculture, was considered in detail by the Committee at the request of the Chief Secretary to Government. The Committee, after exhaustively examining the various proposals, recommended that it should be adopted by Government.

*Coconuts and Oil Palms.*—The Committee considered a report on the research work on coconuts and oil palms carried out by the Department during the previous six months. It was decided that the report, with certain omissions, should be communicated to the press.

*Padi Stem Borers and Locusts.*—The Committee reviewed the progress made

in relation to research work on padi stem borers carried out by the Department in the Krian District and at headquarters.

The present position in relation to locusts was explained, it being pointed out that entomological authorities considered that the change from the solitary to the swarm phase by these insects occurred as a time function. A careful watch was being kept on the locusts recently discovered in Negri Sembilan. In order to deal with such swarms, if they materialised, flame throwers of the type which had proved successful in Palestine, had been ordered by cable.

*Pineapple Experiment Station.*—The Committee was informed that an area of 30 acres situated in the centre of the pineapple growing area in Singapore had been obtained for the purpose of establishing an experiment station for the investigation of the manurial and cultural requirements of the crop, and also in order that the varieties of pineapples might be closely studied.

*Propaganda Van.*—The progress of the work in connection with the organisation of a propaganda van which would tour the country displaying cinema films and agricultural exhibits and disseminating general agricultural information among smallholders, was considered by the Committee.

*Coconut Palm Pests.*—Following the suggestions made at the last meeting, the Committee was informed that work has commenced on the preparation of a manual on the principal insect pests of the coconut palm and the methods of controlling them. The work would be couched in simple language and would constitute a handy work of reference for coconut planters.

*Development of the Tea Industry.*—In pursuance of a recommendation of the Special Sub-Committee on Tea, the Government selected Mr. E. A. Curtler, Assistant Agriculturist to visit Ceylon, Assam and Southern India with a view to studying tea research work. This officer was at present on this tour. On his return he will be placed in charge of the Experiment Station at Cameron's Highlands, where it is proposed considerably to extend the departmental experiments on tea.

Other matters discussed by the Committee were the statistical services of the Department, derris root as an insecticide, the operation of the oil palm factory at Serdang, experiments on the storage of rice carried out by the Department and projected work on the standardisation of fungicides for use in the treatment of bark diseases of rubber trees.

The Committee asked that information should be obtained concerning the whale oil industry, the development of which had resulted in the entry of refined whale oil in the market in competition with coconut and other edible oils.

## Appointment.

Mr. G. H. Corbett, Entomologist, has been appointed Consulting Entomologist, Institute for Medical Research, F.M.S. from June 1st, 1930.

## Leave.

Major C. D. V. Georgi, O. B. E., Acting Agricultural Chemist, returned from leave of absence on 21st August, 1930.

# MARKET PRICES.

## August, 1930.

*Rubber.*—The average price of rubber in Singapore for the month was 15.55 cents per lb., compared with 17.07 cents for July. The highest price recorded was 16½ cents per lb. on August 1st, while the lowest was 14¾ cents per lb. on 19th August. The average London price for August was 4.84 pence per lb., compared with 5.66 pence for July. The highest price recorded in London during the month was 5 5/16 pence per lb. on August 6th: the lowest, 4 5/16 pence per lb. on 22nd August.

*Copra.*—The average Singapore prices for the month were $6.89 per picul for F.M. quality and $7.11 per picul for S.D. quality, compared with $7.39½ and $7.77½ in July. During the past few weeks, larger supplies have come forward although prices have been slowly declining. At the end of August the market was rather steadier.

*Gambier.*—Singapore average prices for August were Block $9.40 per picul, cube $ 14.54 per picul. The previous month's averages were $8.22½ and $15.55 respectively.

*Nutmegs.*—Average prices in Singapore in August were:—110 per lb. $25.62, 80 per lb. $30 per picul. The previous month's corresponding figures were $30.60 and $34.60.

*Mace.*—Siouw averaged $62.70 per picul; Amboina $33.17 per picul on the Singapore market.

*Pepper.*—Singapore average prices were:—Black $22.09; White, Rio and Sarawak, $30.81; Muntok, White $30.17 per picul. In July the average prices were :—Black $27.62½; White $39.62½. Supplies are coming in freely and a comparatively large volume of business is passing.

*Sago.*—Singapore average price for August were for Flake, small, fair, $6.45½ per picul compared with $5.82 in July; Flour, $3.04 per picul. Market is somewhat firmer.

*Tapioca.*—August average prices in Singapore were:—Flake, small, fair $3.86 against $4.28½ in July: Pearl, medium $5.75 per picul: Pearl, small, fair $5.50 per picul compared with the previous month's average of $5.72½. Supplies have been ample. The market is quiet with moderate transactions.

*Pineapples.*—Average Singapore prices; 1½ lb. cubes and 1½ lb. sliced flat $3.60 per case; 1½ lb. sliced tall $4.18 per case. London buyers shew little interest in consequence of which the market is dull.

*Cloves.*—Average prices quoted in Singapore: Zanzibar $52.66; Amboina $59.66 per picul.

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The above market prices are based on the daily cabled London quotations and the Singapore quotations for rubber; on the Singapore Chamber of Commerce Market Reports covering the period 28th July to 23rd August and on other local sources of information.

1 picul = 133 1/3 lbs.

The dollar is fixed at two shillings and four pence.

# MALAYA RUBBER STATISTICS.

STOCKS OF RUBBER INCLUDING LATEX AND REVERTEX HELD BY DEALERS AND ESTATES OF 100 ACRES AND OVER, THE DECLARED PRODUCTION OF THE SAME ESTATES, IMPORT AND EXPORT FIGURES, AND ESTIMATED FIGURES OF THE PRODUCTION OF ESTATES OF LESS THAN 100 ACRES, FOR THE MONTH OF JULY 1930, IN DRY TONS.

| Territory | Stocks at beginning of month | | | Production by estates of 100 acres and over | | Production by estates of less than 100 acres (estimated) | | Imports | | | | Exports (including re-exports) | | | | Stocks at end of month | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | during the month | | during the year 1930 | | during the month | | during the year 1930 | | | | |
| | Ports | Dealers | Estates of 100 acres and over | during the month | during the year 1930 | during the month | during the year 1930 | Foreign | From Malay States | Foreign | From Malay States | Foreign | Local | Foreign | Local | Dealers | Estates of 100 acres and over | Ports |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) |
| MALAY STATES | | | | | | | | | | | | | | | | | | |
| Federated Malay States ... ... | ... | 8,551 | 13,344 | 13,876 | 74,479 | 9,646 | 64,631 | Nil | 5 | Nil | 42 | 14,819 | 5,452 | 103997 | 36,718 | 9,831 | 15,320 | ... |
| Johore ... ... | ... | 2,297 | 4,698 | 3,863 | 22,771 | 3,881 | 27,509 | Nil | 3 | Nil | 12 | 976 | 6,759 | 6,641 | 44,591 | 2,043 | 4,964 | ... |
| Kedah ... ... | ... | 325 | 2,146 | 2,385 | 12,603 | 1,243 | 8,719 | 8 | Nil | 30 | Nil | 879 | 2,569 | 4,747 | 16,679 | 418 | 2,241 | ... |
| Perlis ... ... | .. | 11 | 10 | 7 | 57 | 13 | 101 | Nil | Nil | Nil | Nil | Nil | 24 | Nil | 173 | 7 | 10 | ... |
| Kelantan ... ... | ... | 111 | 51 | 103 | 1,606 | 637 | 2,770 | 4 | Nil | 26 | Nil | 101 | 503 | 458 | 4,001 | 144 | 158 | ... |
| Trengganu* ... | ... | 55 | 50 | 126 | 822 | 63 | 411 | Nil | Nil | Nil | Nil | Nil | 189 | Nil | 1,234 | 55 | 50 | ... |
| STRAITS SETTLEMENTS | | | | | | | | | | | | | | | | | | |
| Malacca ... ... | ... | 2,082 | 1,601 | 1,356 | 7,857 | † 2,621 | 20,941 | Nil | 1,347 | Nil | 10,010 | 3,433 | Nil | 25,747 | Nil | 2,328 | 1,175 | ... |
| Province Wellesley | ... | 92 | 571 | 621 | 2,869 | | | | | | | | | | | 121 | 733 | ... |
| Dindings ... ... | ... | 57 | 143 | 103 | 628 | | | 698 | 3,702 | 5,921 | 22,946 | 5,027 | | 38,399 | | 120 | 172 | ... |
| Penang ... ... | 1,398 | 4,322 | 16 | 12 | 71 | | | | | | | | | | | 4,869 | 15 | 1,524 |
| Singapore ... | 2,865 | 30,448 | 368 | 252 | 1,555 | | | 9,722 | 10,439 | 67,330 | 70,386 | 18,770 | | 143,344 | | 31,099 | 376 | 4,474 |

ANALYSIS OF COLONY AND FEDERATED MALAY STATES DEALERS' STOCKS AT END OF MONTH, IN DRY TONS.

| Class of Rubber | Federated Malay States | Singapore | Penang | Province Wellesley, Dindings and Malacca | Johore | Gross total |
|---|---|---|---|---|---|---|
| (20) | (21) | (22) | (23) | (24) | (25) | (26) |
| Smoked sheet ... | 7,164 | 15,189 | 3,046 | 1,532 | 891 | 27,822 |
| Crepe ... ... | 644 | 13,865 | 1,050 | 728 | 253 | 16,540 |
| Unsmoked sheet ... | 895 | 2,045 | 773 | 309 | 503 | 6,049 |
| Scrap and lump ... | 1,128 | | | | 396 | |
| Total all Grades ... | 9,831 | 31,099 | 4,869 | 2,569 | 2,043 | 50,411 |

*Notes.*—1. Stocks on estates of less than 100 acres and stocks in transit on rail, road or local steamer are not ascertained.

2. The production of estates of less than 100 acres is estimated from the formula: Production + Imports + Stocks at beginning of month = Exports + Stocks at end of month; i.e., Column (7) = Columns (13) + (14) + (17) + (18) + (19) — (2) — (3) — (4) — (5) — (9) — (10).

3. Colony Dealers' Stocks are as published in Return I. & E. 6, dated August 11. The ratio of the reduction on wet rubber is taken to be 25% applicable to wet stocks at the ports of Singapore and Penang.

4. Malay States Dealers' Stocks are reduced by the following fixed ratios: Unsmoked sheet, 15%; Wet Sheet, 25%; Scrap, Lump, etc., 40%.

5. Foreign Imports are as published in Return I. & E. 5, dated August 5, reduced to dry weight by the percentage for July in Note 3; (*S.S. Gazette* Notification No. 1603/1930).

6. Foreign exports of each State and Settlement are those published in the Malaya Monthly Trade Return (Appendix II), and are distinct from Ocean-Shipments as published in Return I and E. 4, dated August 5, (Appendix IV to Monthly Trade Return).

*7. Stocks and production in Trengganu are estimated from figures supplied by the Commissioner of Lands.

8. All statements are brought up to date monthly and any inaccuracies that may be disclosed are corrected in the totals; the latest publication, therefore, is always the most reliable.

†9. This hypothetical figure, based on the formula quoted in Note 2, contains whatever errors exist in the Columns comprising it and may therefore be expected to fluctuate from month to month. A truer indication of production will be the monthly average over as long a period, for which figures can be estimated, as possible.

J. I. MILLER, M.C.S.,
*Acting Registrar-General of Statistics, S.S. and F.M.S.*

Singapore, August 18, 1930.

# SUMMARY OF PADI REPORTS, FEDERATED MALAY STATES AND STRAITS SETTLEMENTS, FOR THE MONTH OF JULY, 1930.

## NEW SEASON COMMENCING.

| State | District | Acreage of Padi Land | Acreage planted | Percentage 4 to 3 | Gross Crop | Crop per Acre 6 to 4 | Remarks |
|---|---|---|---|---|---|---|---|
| | | Acres | Acres | | Gantangs | | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| **Perak** | Perak North : | | | | | | |
| | Krian | 53,250 | ... | ... | ... | ... | About half of the nurseries sown. Lack of water delaying sowing. |
| | Larut | 8,525 | ... | ... | ... | ... | Drought holding up planting. |
| | Selama | 3,450 | ... | ... | ... | ... | Some sowing done—drought causing de lay. |
| | Kuala Kangsar | 13,997 | ... | ... | ... | ... | Only 200 acres planted. Preparation for sowing and planting in hand. |
| | Upper Perak | 3,739 | ... | ... | ... | ... | Nurseries sown and land being prepared for planting. |
| | Perak South : | | | | | | |
| | Six mukims | 14,187 | ... | ... | ... | ... | Preparations for planting generally in hand. In some mukims nurseries sown and planting commenced. |
| | | 97,148 | ... | ... | ... | ... | |
| **Pahang** | West : | | | | | | |
| | Temerloh | 12,311 | ... | ... | ... | ... | Transplanting in hand. |
| | Raub | 5,112 | ... | ... | ... | ... | do. |
| | Kuala Lipis | 5,576 | ... | ... | ... | ... | do. |
| | Bentong | 783 | ... | ... | ... | ... | do. |
| | | 23,782 | ... | ... | ... | ... | |
| **Negri Sembilan** | Seremban | 4,904 | ... | ... | ... | ... | Transplanting started. |
| | Kuala Pilah | 18,010 | ... | ... | ... | ... | Preparing Sawah. |
| | *Port Dickson | 159 | ... | ... | ... | ... | Transplanting started. |
| | Jelebu | 3,116 | ... | ... | ... | ... | Transplanting almost completed. |
| | Tampin | 2,609 | ... | ... | ... | ... | Transplanting started. |
| | Rembau | 7,897 | ... | ... | ... | ... | Preparation of sawah completed. |
| | | 36,695 | ... | ... | ... | ... | |

* This area is smaller than that previously published due to the excision of land now regarded as dry padi land of which 450 acres have been planted.

SUMMARY OF PADI REPORTS, FEDERATED MALAY STATES AND STRAITS SETTLEMENTS, FOR THE MONTH OF JULY, 1930.—(Continued).

| State or Settlement | District | Acreage of Padi Land | Acreage planted | Percentage 4 to 3 | Gross Crop | Crop per Acre 6 to 4 | Remarks |
|---|---|---|---|---|---|---|---|
| (1) | (2) | Acres (3) | Acres (4) | (5) | Gantangs (6) | (7) | (8) |
| **Selangor** | Ulu Langat | 2,670 | ... | ... | ... | ... | Transplanting started. |
| | Kuala Lumpur | 797 | ... | ... | ... | ... | do. |
| | Ulu Selangor | 1,205 | ... | ... | ... | ... | do. |
| | Kuala Selangor | 18,564 | ... | ... | ... | ... | do. |
| | | 23,236 | ... | ... | ... | ... | |
| **Straits Settlements** | Malacca, Central | 16,473 | ... | ... | ... | ... | Transplanting commenced. |
| | Alor Gajah | 11,239 | ... | ... | ... | ... | Sowing of nurseries in progress. |
| | Jasin | 5,756 | ... | ... | ... | ... | Planting in Progress. |
| | | 33,468 | ... | ... | ... | ... | |
| | P. Wellesley, North | 18,560* | ... | ... | ... | ... | Planting in progress—retarded due to lack of rain. |
| | Central | 10,539 | ... | ... | ... | ... | Clearing in progress but land still dry. |
| | South | 4,649 | ... | ... | ... | ... | Progress being made in irrigated area only. |
| | | 33,748 | ... | ... | ... | ... | |
| | Penang | 4,000 | ... | ... | ... | ... | |
| | Singapore | nil | ... | ... | ... | ... | |

* 350 acres of dry padi not included in this total.

N.B.—The figures given in the latest return under column 3 may be accepted as more accurate than any given in previous returns.

# METEOROLOGICAL SUMMARY, MALAYA. JULY, 1930.

| Locality | Air Temperature in degrees Fahrenheit | | | | | | | Earth temperature | | Rainfall | | | | | | | | | Bright Sunshine | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Means of | | Mean of A and B | Absolute Extremes | | | | At 1 foot | At 4 feet | Total | | Most in a day | Number of days | | | | | | Total | Daily Mean | Per cent | Length of Day |
| | A. Max. | B. Min. | | Highest Max. | Lowest Min. | Lowest Max. | Highest Min. | | | | | Amt. | Precipitation* | Precipitation 1mm. or more | Thunderstorm | Thunder heard | Fog morning obs. | Gale force 8 or more | | | | |
| | °F | °F | °F | °F | °F | °F | °F | °F | °F | in. | mm. | ins. | | | | | | | hr. | hr. | % | hr. |
| Railway Hill, Kuala Lumpur, Selangor ... | 90.4 | 71.6 | 81.0 | 95 | 69 | 85 | 73 | 82.9 | 83.6 | 1.17 | 29.7 | 0.53 | 6 | 3 | 2 | 10 | 1 | | 202.15 | 6.52 | 52 | 12.3 |
| Bukit Jeram, Selangor ... | 90.4 | 72.8 | 81.6 | 93 | 70 | 88 | 75 | 87.3 | 88.2 | 0.92 | 23.4 | 0.52 | 4 | 4 | 1 | 15 | ... | | 247.10 | 7.97 | 65 | 12.3 |
| Sitiawan, Perak ... | 90.9 | 72.3 | 81.6 | 94 | 68 | 85 | 75 | 84.8 | 84.7 | 2.46 | 62.5 | 1.53 | 8 | 5 | 4 | 15 | ... | | 236.75 | 7.64 | ... | .. |
| Kroh, Perak ... | 86.7 | 69.5 | 78.1 | 90 | 66 | 77 | 73 | 81.2 | 83.1 | 4.97 | 126.3 | 1.28 | 14 | 10 | .. | 3 | 1 | | 201.65 | 6.50 | ... | ... |
| Temerloh, Pahang ... | 90.4 | 72.4 | 81.4 | 94 | 68 | 84 | 75 | 83.2 | 85.6 | 1.78 | 45.2 | 1.06 | 8 | 6 | ... | 13 | 11 | | 214.00 | 6.90 | 56 | 12.3 |
| Kuala Lipis, Pahang .. | 89.6 | 72.0 | 80.8 | 93 | 69 | 85 | 74 | 84.2 | 84.1 | 4.66 | 118.4 | 1.81 | 9 | 9 | 8 | 14 | 19 | | 210.55 | 6.79 | ... | ... |
| Kuala Pahang, Pahang ... | 87.3 | 74.7 | 81.0 | 91 | 72 | 86 | 78 | 86.2 | 86.7 | 6.27 | 159.3 | 3.15 | 13 | 8 | 9 | 18 | ... | | 251.10 | 8.10 | 66 | 12.3 |
| Cameron's Highlands, Rhododendron Hill, Pahang ... | 72.3 | 59.8 | 66.1 | 76 | 59 | 66 | 62 | ... | ... | 3.41 | 86.6 | 1.15 | 11 | 9 | 4 | 17 | 4 | | 189.70 | 6.12 | 49 | 12.4 |
| Cameron's Highlands, Tanah Rata | 73.0 | 54.4 | 63.7 | 76 | 50 | 69 | 60 | 69.8 | 69.7 | 2.89 | 73.4 | 1.04 | 11 | 9 | 4 | 17 | 4 | | 174.50 | 5.63 | 45 | 12.4 |
| Fraser's Hill, Pahang ... | 73.4 | 62.5 | 67.9 | 77 | 60 | 69 | 64 | 70.3 | 71.3 | 3.52 | 89.4 | 1.02 | 15 | 11 | 1 | 8 | 13 | | 181.35 | 5.85 | 48 | 12.3 |
| Mount Faber, Singapore ... | 88.5 | 77.7 | 83.1 | 92 | 71 | 86 | 80 | 83.5 | 84.3 | 5.41 | 137.4 | 2.02 | 10 | 8 | 2 | 10 | ... | | 267.20 | 8.62 | 71 | 12.2 |
| Butterworth, Province Wellesley | 88.5 | 74.5 | 81.5 | 90 | 72 | 86 | 77 | 85.7 | 84.7 | 3.83 | 97.5 | 1.60 | 10 | 7 | 1 | 6 | ... | | 212.70 | 6.86 | ... | ... |
| Bukit China, Malacca ... | 85.8 | 74.0 | 79.9 | 88 | 68 | 83 | 76 | 83.6 | 84.7 | 8.56 | 217.4 | 2.30 | 13 | 10 | 4 | 7 | ... | 3 | 250.40 | 8.08 | 66 | 12.2 |
| Kluang, Johore ... | 88.8 | 71.0 | 79.9 | 91 | 68 | 85 | 74 | 82.2 | 82. | 4.75 | 120.7 | 1.80 | 15 | 13 | 15 | 11 | ... | | 216.00 | 6.96 | 57 | 12.2 |
| Bukit Lalang, Mersing, Johore... | 89.3 | 72.8 | 81.0 | 91 | 70 | 86 | 75 | 82.1 | 82.1 | 6.05 | 153.7 | 1.83 | 19 | 16 | ... | 22 | 1 | | 226.65 | 7.31 | 60 | 12.2 |
| Alor Star, Kedah ... | 88.5 | 74.7 | 81.6 | 91 | 73 | 84 | 77 | 86.5 | 86.6 | 4.25 | 108.0 | 1.36 | 16 | 10 | ... | 19 | ... | | 211.25 | 6.81 | ... | ... |
| Kota Bharu, Kelantan ... | 89.5 | 73.9 | 81.7 | 92 | 71 | 85 | 77 | 85.3 | 85.0 | 5.85 | 148.6 | 0.76 | 15 | 13 | ... | 18 | ... | | 206.15 | 6.65 | ... | ... |
| Kuala Trengganu, Trengganu... | 89.0 | 73.0 | 81.0 | 91 | 69 | 86 | 76 | 83.7 | 84.8 | 11.06 | 280.9 | 2.62 | 14 | 11 | 10 | 14 | 2 | | 228.85 | 7.63 | ... | ... |

* Precipitation ·01 inch or more when measurement is in inches ·2mm. or more when measurement is in millimetres.

Compiled from Returns supplied by the Meteorological Branch, Malaya.